

PRELIMINARY
TRAINEE'S GUIDE
for
ELECTRONICS TECHNICIANS

**Shipboard Equipment
Indoctrination Course**

**COMMUNICATION
SYSTEMS**

VOLUMES 1 and 2
INFORMATION SHEETS
ASSIGNMENT SHEETS
JOB SHEETS

December 1967

FOREWORD

This Preliminary Trainee's Guide for Communication Systems contains the Information Sheets, Assignment Sheets, and Job Sheets for the Electronics Technicians, Shipboard Equipment Indoctrination Course.

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INTRODUCTION

SAFETY

Extreme danger of personal injury or damage is present when power is applied to electronics equipment. It is imperative that all safety precautions and warnings given in the technical manuals be followed. Observing safety precautions is very important to you and everyone that works with you.

HOW TO USE THIS STUDENT GUIDE

This student guide does not supersede any existing publications, but, supplements the information contained in many publications. The primary purpose of this guide is to provide self study material that requires a minimum of supervision. Each lesson contains study assignments and information sheets. Beginning with lesson one, study the assignments given in the assignment sheet, and study the information sheet.

RELATED MATERIALS

NAVPERS 0967-046-9010 Technical Manual for Telegraph Terminal AN/UCC-IC(V)

AN/UCC-1C(V), GENERAL DESCRIPTION AND OPERATION

STUDY ASSIGNMENT

NAVSHIPS 0967-046-9010, Technical Manual for Telegraph Terminal AN/UCC-1C(V), Pages 1-1 through 1-14.

STUDY QUESTIONS

1. List the five major units of the AN/UCC-1C(V).
2. What is the center-to-center frequency spacing for the narrow-band channels?
For wide band channels?
3. When referring to narrow band channels, what is the frequency spacing between a mark signal on one channel and the space signal on the next higher channel?
4. List the three types of communications circuits the AN/UCC-1C(V) is designed for use with.
5. What is the purpose of the Frequency Shift Keyer, KY-558(P)?
6. What is the purpose of the Frequency Shift Converter, CV-1920(P)?
7. List the four major functions performed by the Control Attenuator, C6554.
8. Draw a block diagram of a two channel AF diversity system using RF diversity for send and receive.

9. What is the frequency separation between separate diversity pairs?

10. What is the maximum baud rate that the narrow band keyers are capable of?
The wide band keyers?

MULTICHANNEL TONE COMMUNICATIONS

INTRODUCTION

The material in this information sheet was extracted from the report of Communications Exercise Base Line II, conducted in EASTPAC in October, 1966. Every type commander and virtually every ship type was represented in the exercise allowing exploration of Fleet communications as they exist today. The purpose of this information sheet is to acquaint you with some of the equipment used and problems encountered in tone terminal communications systems. It is intended that this knowledge will assist you to more thoroughly understand and effectively maintain systems in the fleet.

REFERENCES

Baseline II Communications Information Booklet

INFORMATION

MULTI-CHANNEL TERMINAL EQUIPMENT

Multiplexing is the term used to define the art of combining more than one channel into one composite channel or trunk and send more than one message at a time on one transmitter. Multiplexing is usually shortened to the term "MUX" by radiomen. The multi-channel broadcast is a good example of "MUXING" and "DEMUXING". The ship utilizes equipment at the receiver end of the broadcast to "DEMUX" the signal into the individual channels.

Multi-channel broadcasts and ship/shore terminations utilize frequency multiplexing whereby each channel of the composite tone package of the broadcast or termination is assigned an audio frequency. The lowest audio frequency used is 425 cycles per second and the highest frequency used is 2975 cycles per second. The audio tones for the channels are 170 cycles per second apart and hence there are tones at 425, 595, 765, 935, 1105, 1275, etc. There are sixteen tones between 425 and 2975 cycles per second that are used. This gives a capability of sixteen separate channels of intelligence under some conditions.

In order to give ships more reliability in receiving a multi-channel broadcast, the shore station "twins" two channels and keys them with the same channel intelligence. Channels are keyed with the same intelligence to overcome "selective fading" and give the receiving station two chances of getting the signals at one time. The twinning uses frequencies separated by 1360 cycles to overcome the possibility of selective fading causing hits on the circuits. Intelligence from one channel is used to key 425 cycles per second and 1785 cycles per second channels or tones simultaneously. The ship receives both of these tones and converts them to DC and operates a teletype machine from the best of the two signals. The unit that combines the two

signals is called a combiner unit, similar to the comparator unit in an AN/URA-8. The theory is that if one tone, 425 cps for instance, fades out for an instant, the other tone, 1785 cps, might be loud and clear. Other tones are twinned for other teletype channels such as 595 cps and 1955, 765 cps and 2125 cps, etc. This limits the 16 tones in most MUX/DEMUX equipments to eight channels of intelligence but gives better reliability by overcoming some of the effects of selective fading. Utilizing two frequencies like this is referred to as frequency diversity.

Another form of frequency diversity is available to the ships in both ship/shore terminations and broadcast reception. On the broadcast there are many transmitters on the air with the same composite package of tones for the ships to receive. The ship can tune receivers to two of these frequencies and feed both sets of audio tones to the AN/UCC-1. This gives the equipment two separate audio inputs, from two different transmitters on two different frequencies, to help maintain a good solid signal into the AN/UCC-1. Frequencies should be chosen which are as close together as possible such as 8 meg and a 12 meg frequency or a 12 meg and a 17 meg frequency. Frequencies that are wide spread, such as a 4 meg and a 17 meg, should not be used for normal operation of the DEMUX equipment. There may be sufficient time delay in the signals from these two transmitters to reach the ship that added distortion may be added to the circuit within the combine units of the AN/UCC-1.

On the low frequency portion of multi-channel broadcasts, due to limitations of antenna bandwidth and the bandwidth of the transmitter itself, only the lower frequency audio tones are transmitted. These tones are from 425 cycles per second to 1615 cycles per second. There is no tone diversity available. This is not a great hindrance, however, in that selective fading is not normally encountered on low frequency transmission paths.

Ship/shore termination equipment utilizes the same equipment as the multi-channel broadcast except that the shipboard equipment has a send capability as well as a receive capability. The same operation exists on a multi-channel (VFTG) ship/shore termination as with multi-channel broadcast. There is one slight difference which is an asset in circuit reliability. The shipboard operators control the frequency of the shore transmitters by requesting the two frequencies that the shore transmitters shall be operated. The ship operator can choose two frequencies that are very close together and hence will have the same propagation path from the shore transmitter to the ship. This condition gives very good frequency diversity and the ship should experience extremely good reception.

Reception on the ship of any tone diversity tone package can be good without utilizing the tone diversity. If one of the audio tone channels is bad in the AN/UCC-1 equipment, the output signal of the two audio channels involved may be so highly distorted that it cannot be copied. In this case, when one intelligence channel is unreadable or highly garbled and the other channels of the ship/shore termination or the multi-channel broadcast are good some remedial action can be taken. A technician on the ship can untwin the channels concerned and you can try the individual channels and sometimes copy the signal "fiver" on one channel.

MUX and DEMUX theories are not difficult and if the shipboard operator becomes familiar with the concept of sending more than one intelligence at a time he can isolate troubles and get good reception in most cases.

SHIP/ShORE MULTIPLEX TERMINATIONS

Ship/shore multiplex terminations were measured aboard the USS ELDORADO. The parameters examined and recorded were frequency of the carrier, tone frequencies, relative carrier output, and bias distortion.

Continuous samples were taken during the course of the exercise. Almost without exception, it was found that the shore stations were on the correct frequency and well within tolerance. Numerous readings were measured on 45 different A2/A3 frequencies. Of these, only four frequencies can be transmitted from shipboard transmitters in a fully synthesized mode. In order to transmit in a synthesized mode, the carrier frequency must be in an even increment of 1 KC. Of those measured, NONE were within tolerance. The average error was 152 cycles. This indicates that the equipments either CANNOT be operated properly, or that operators are choosing the wrong mode of operation.

The solution is obvious. Maintenance personnel must restore the equipment to designed operating standards, and operators must choose the correct mode. Present instructions (COMFIRSTFLTNOTE 2400 of 31 October) dictate that all A2 and A3 transmissions will be made in a synthesized mode.

Figure 1 indicates that only 30% of the transmissions showed proper selection of carrier. Some of these were too far out of tolerance to permit synthesized reception of signals. The remaining 70% indicate either personnel error or equipment malfunction.

Figure 2 indicates equipment accuracy. Transmitter and receiver frequencies which differ by more than five cycles result in degraded copy. Beyond ten cycles difference, the termination is useless. Note that 40% of the transmissions were beyond limits and required AFC controlled receivers which require that a pilot carrier be transmitted in addition to the tones. This results in improper mode of transmission, and also utilizes power which could otherwise be conveying intelligence.

ALCOM 80 contains recent guidance on channalization and frequencies for termination of multi-channel Ship/Shore terminal equipment and should be read by all personnel concerned with multi-channel terminations.

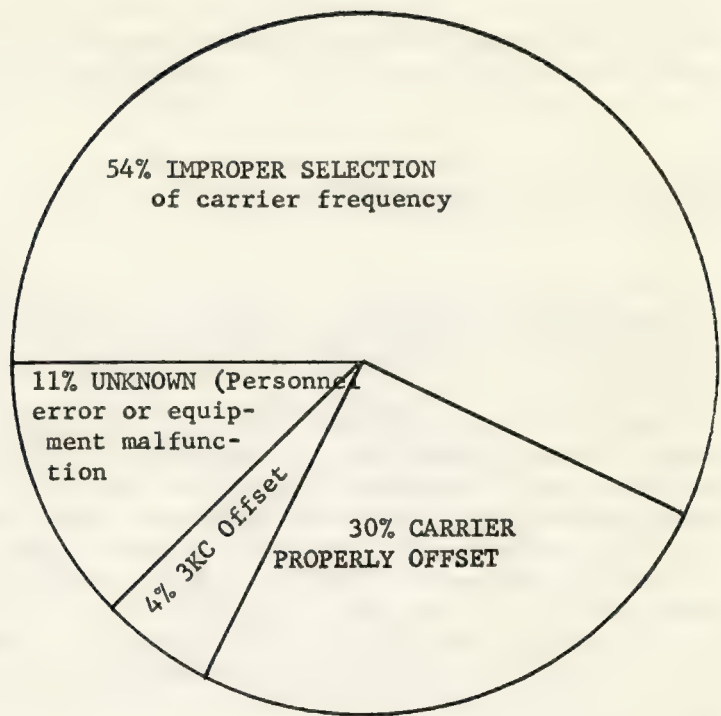


FIGURE 1. SELECTION OF PROPER CARRIER FREQUENCY (VFTG)

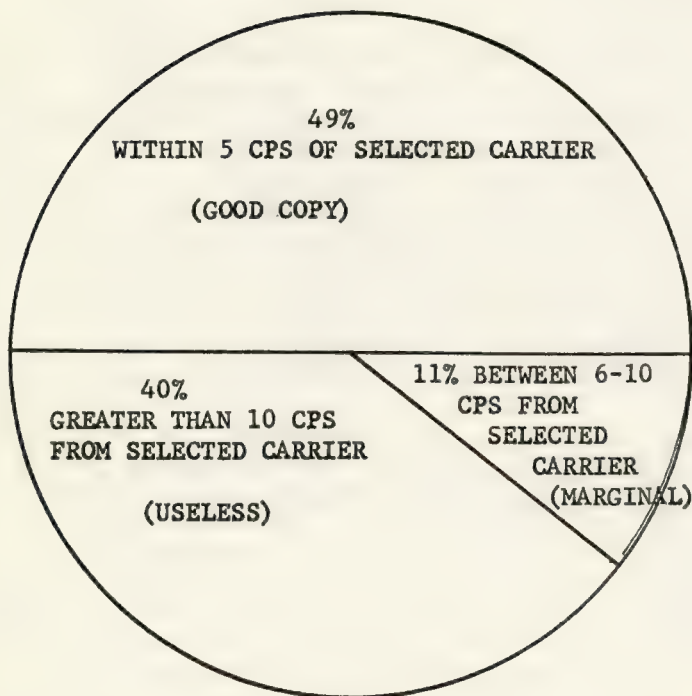


FIGURE 2. FREQUENCY ACCURACY OF TRANSMITTERS (VFTG TERMINATIONS)

TONES AND VFTG CIRCUITS

The tones generated by a UCC-1 VFTG send terminal, or the FGC-60 equivalent shore send terminal, cover the audio frequency range of 382.5 cycles per second. Normally, two tones are utilized for each intelligence channel to give close frequency diversity to decrease the effects of selective fading. The UCC-1, then, normally has an 8-channel intelligence capability with 16 tones. The pairs of audio tones used on a given intelligence channel are separated by 1360 cycles per second.

Due to limitations on crypto equipments, traffic handling capability, teletype machines and personnel, a ship normally utilizes only four intelligence channels --- eight tones. The remaining tones for the unused channels of the UCC-1 serve no useful purposes.

The blocking mode of operation, sometimes called "idling", can often be employed in multi-channel operation over VFTG circuits to overcome slow fading, weak signals or noise which may not permit operations in the twinning mode.

Blocking is accomplished by inserting dummy plugs into the tone equipment jacks or grounding the output of each separate transmit channel as required.

By halting transmissions on given channels the transmitted power used in these channels is concentrated in the channels still in use. The number channels blocked depends upon the conditions of the frequency or frequencies in use at the time.

CAUTION: When blocking or idling is employed be sure to readjust the input levels to the transmitter to maintain peak output power. The transmitter output is directly related to the audio input power.

During periods of marginal communications tones should be blocked to obtain the following advantages:

1. Slightly more power "per tone channel" can be transmitted without overloading the transmitter. This is only a very slight increase in power and care must be given to ensure that the transmitter is not overdriven to the point that distortion takes place. Readjust levels at the UCC-1 and check transmitter to ensure it is not being over modulated.
2. With fewer tones being transmitted the chances of shipboard generated radio frequency interference are decreased. With fewer tones the chances of intermodulation distortion have decreased tremendously as far as the number of by-products mathematically available are concerned.
3. Decreased bandwidth also lessens the chances of interference on other ships using adjacent channel operation. By blocking the higher audio frequencies from the tone package a "guard band" is placed between this tone package and the next higher channel frequency. This causes less interference throughout the fleet.
4. If the front end, on the receiving end of the circuit, is driven into the non-linear area of conduction the fewer tones in the tone package will result in fewer by-products being generated within the receiver.

Tone blocking should be practiced until it becomes normal operation. It makes good common sense to only transmit the tones that are used to convey intelligence and to block the unused tones.

It must be remembered that channels 1, 2, 3, and 4 are not the only channels that can be used for terminations. In some cases it may be advantageous to utilize channels 5, 6, 7, and 8. Any combination of channels may be utilized. Untwining can also increase the number of channels available for ships that only have a four channel capability. Initiative and desire to communicate should be the guiding doctrine in the use of VFTG MUX equipment.

TUNING MULTI-CHANNEL CIRCUITS ON RECEIVERS

Multi-channel circuits permit more than one channel of intelligence to be transmitted and received over one frequency. Only one transmitter and one receiver are necessary at each end. In ship/shore terminations, one additional transmitter and receiver are used to give better reliability although one receiver will operate the circuit. In broadcasts, the shore station runs many frequencies in order to provide reception to ships all over the area of responsibility for that particular shore station.

The single channel radio teletype signal has a shift of 850 cycles and can be readily tuned in on practically any receiver with just a little care. If the audio from the receiver enters the teletype converter at slightly different frequencies than the converter is designed for, the circuit will probably operate QRK 5 anyway. In multi-channel operation, the shift on each channel is only 85 cycles - one tenth the shift that single channel radio teletype circuits use. These circuits are much more critical and difficult to tune. The result of a frequency error on multiplex is ten times more critical than would be indicated by the difference in the amount of shift. As an example: A frequency error of 500 cycles on FSK will introduce approximately 5% distortion to the copied signal; a frequency error of only 5 cycles in MUX operation will introduce this same 5% distortion.

With suppressed carrier single sideband type of transmission, the receiver picks up the individual channel frequencies in one package but has no carrier frequency in the package to use as a reference. The "carrier" frequency is actually generated and injected into the package of tones within the receiver on board ship. Tuning the receiver produce this injected carrier into the tone package and then the tones are detected (demodulated) and appear as audio. This audio is fed to UCC-1 equipment for conversion into teletype signals.

With the receiver on the correct frequency, listen to the audio and make sure that the frequency is clear with little or no noise for interference. Try several antennas and patch cords to obtain the strongest and clearest reception possible. If the receiver has an antenna tuning device, be sure and peak this for maximum received signal. If the signal is extremely strong, decrease the amount of radio frequency gain so that the AGC action of the receiver will not distort the audio output to the receiver. Adjust the audio level out of the receiver to the correct level for the input of the device used to convert the audio tones to teletype signals. Normally this will be a UCC-1 equipment. Adjust the level out of the receiver after the patches have been made to feed the signals into the UCC-1.

Keep a second receiver tuned in to another frequency on either broadcast or ship termination type circuits to give an instant back-up if one frequency fails or a transmitter goes off the air at the shore station. Keep an audio monitor on the two frequencies to make sure that they are both of traffic quality at all time. If one frequency goes bad, QSY the receiver to a new frequency before the other frequency goes bad also. If two signals are found of the same quality, the UCC-1 equipment can be set up for receiving and comparing both these frequencies in frequency diversity. In order to use this mode of operation the UCC-1 must be set up in accordance with the instruction book and additionally both frequencies must either be broadcast from the same transmitting location or locations that are the same distance from the ship.

Not all receivers on board ship will operate efficiently on MUX signals as the receivers tend to drift in frequency. They will drift only a few cycles by that may be enough to highly distort a circuit. The receivers commonly used now for MUX signals are the R-1051, AN/WRR-2 and AN/SRR-19 receivers. The WRR-2 receiver cannot be used on frequencies where the carrier must be injected a half kc/s points. The other receivers on board ship such as R-390 and SRR-11 are not suitable for MUX operation unless in an emergency.

The signal pulses on diversity channels, twinned pairs, must arrive simultaneously at the terminal equipment in order that the channels, 4 on Quad Diversity, may be used in diversity operation. Errors in arrival time, delay distortion, were introduced by the shore transmitting stations, 1-5 milliseconds, during operation BASE LINE. Because of this delay, compensation at the receive MUX terminal should be made while receiving the desired station. The procedures in the UCC-1 instruction book require that the transmit station send reversal type signals during alignment of the equipment with the test set which is provided. This procedure is not always possible especially on broadcast circuits, however, the adjustment can be made while traffic is being passed by measuring delay between channels with a dual trace oscilloscope.

AN/UCC-1C(V) GENERAL DESCRIPTION & OPERATION

INTRODUCTION

The maximum permissible number of intellegible transmissions taking place in the radio spectrum per unit of time is being increased through the use of multiplexing. Multiplexing involves the transmission of several intelligible signals during the same period of time normally required for the transmission of a single signal.

Either of two methods of multiplexing may be used. These are time division and frequency division multiplexing.

Frequency division multiplexing is the older of the two. In this system different subcarrier frequencies are modulated by the signals of different channels, transmitted over the same cable or on the same radio frequency carrier, then separated by filters before being demodulated. The total bandwidth required for a frequency division multiplexing system is the sum of the bandwidths of the individual channels, plus the sum of the necessary guard band frequencies between channels

The AN/UCC-1C(V) Teletype Terminal Equipment is a modular terminal for frequency shift carrier telegraph communication employing a frequency division multiplex system over single-sideband radio circuits, voice frequency wireless, microwave circuits, or other transmission systems. It is compatible in operation and can replace the FGC-29, AN/FGC-60 and AN/FGC61.

REFERENCE

NAVSHIPS 0967-046-9010 Technical Manual for Telegraph Terminal
AN/UCC-1C(V)

INFORMATION

AN/UCC-1C(V) GENERAL DESCRIPTION and OPERATION

The Telegraph Terminal is a modular carrier-telegraph equipment, see figure 1, intended for use with single-sideband or twin-sideband radio circuits, voice-frequency wire lines, or microwave circuits.

The Telegraph Terminal comprises the following equipment:

1. Cabinet, Electrical Equipment, CY-4639/UCC-1C(V)

2. Keyer, Frequency Shift, KY-558(P)/UCC-1C(V)
3. Converter, Frequency Shift, CV-1920(P)/UCC-1C(V)
4. Control-Attenuator, C-6554/UCC-1C(V)
5. Test Set, Telegraph, TS-2232/UCC-1C(V)

Except for item 5, of which only one is required, component quantities are determined by installation requirements. Items 2, 3, and 4 are plug-in components that are mounted in item 1. Item 5 is a separate unit.

Depending upon the component quantities and configuration used, the Telegraph Terminal:

Can provide up to 16 narrow-band channels within a 382-to-3017-cps bandwidth. Within an 1870-to-3315-cps bandwidth, a maximum of four wide-band channels (one per two narrow-band channels) are available.

Can operate as a non-diversity, frequency-diversity, space-diversity, or r-f diversity system, or any combination thereof.

The Telegraph Terminal incorporates special testing equipment required for aligning its keying and converting circuitry.

CABINET, ELECTRICAL EQUIPMENT, CY-4639/UCC-1C(V), see figure 2. Each Cabinet used in the equipment houses one Control-Attenuator C-6554/UCC-1C(V), and eight Frequency Shift Keyers KY-558(P)/UCC-1C(V) or eight Frequency Shift Converters CV-1920(P)/UCC-1C(V) (or any combination, totaling eight, of the latter two components). The L brackets supplied with the Cabinet allow standard 19-inch relay rack installation. Cabinet interconnector wiring permits diversity combinations, and connection of voice-frequency circuits to individual or parallel composite lines, by means of switch settings on the plug-in units.

KEYER, FREQUENCY SHIFT, KY558(P)/UCC-1C(V), see figure 2. Each Keyer provides one channel that accents d-c telegraph signals from an external loop, and supplies the appropriate voice-frequency mark/space frequency-shift output signal. The keyer provides polar or neutral loop operation without any change in switch setting. Keyer switches may be set to:

1. Allow 60- or 20- ma loop operation,
2. Provide normal or reversed voice-frequency signal sense,
3. Place the output signal on an individual output line or on the composite output line,
4. Enable interconnection of two Keyers, to form a frequency-diversity pair so that a single d-c telegraph input produces outputs at two different voice frequencies, and
5. Enable interconnection of four Keyers to form a frequency-diversity combination so that a single d-c telegraph input produces outputs at four different voice frequencies.

The Keyer has its own power supply; all active Keyer components are contained on a plug-in printed-circuit card that is interchangeable with cards of other Keyers.

CONVERTER, FREQUENCY SHIFT, CV-1920(P)/UCC-1C(V), see figure 2. Each Converter provides one channel that accepts a particular frequency-shift voice-frequency signal, and produces an electronic keying signal for operation of a d-c telegraph loop. Switch settings allow the voice-frequency input to be obtained from either the composite line or an

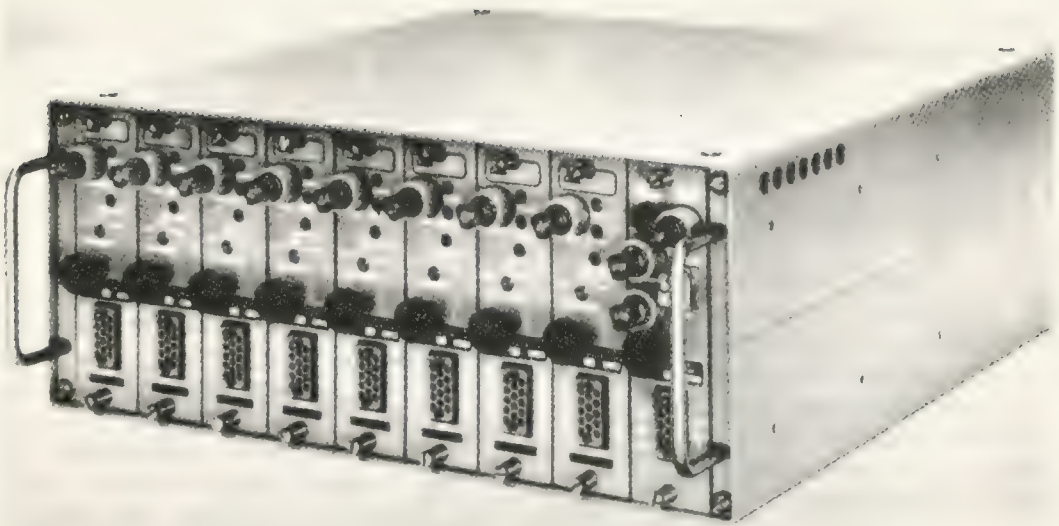


Figure 1- Telegraph Terminal AN/UCC-1C(V)

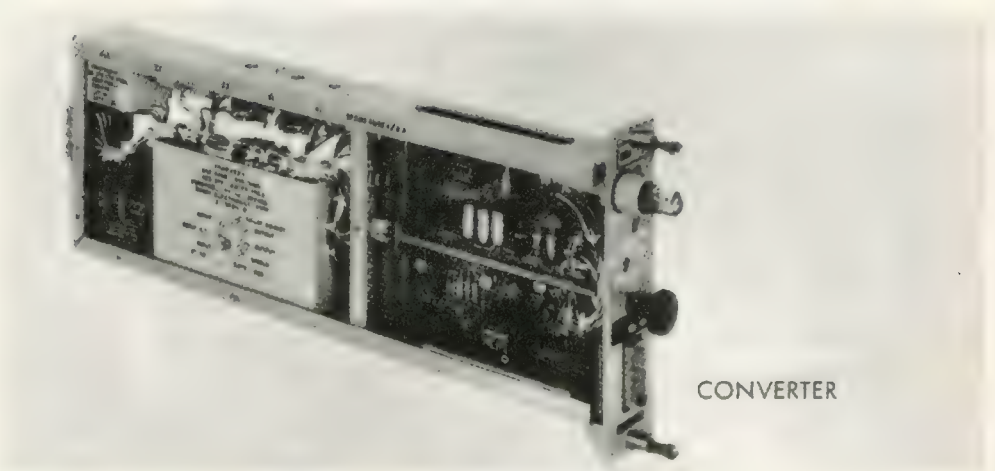
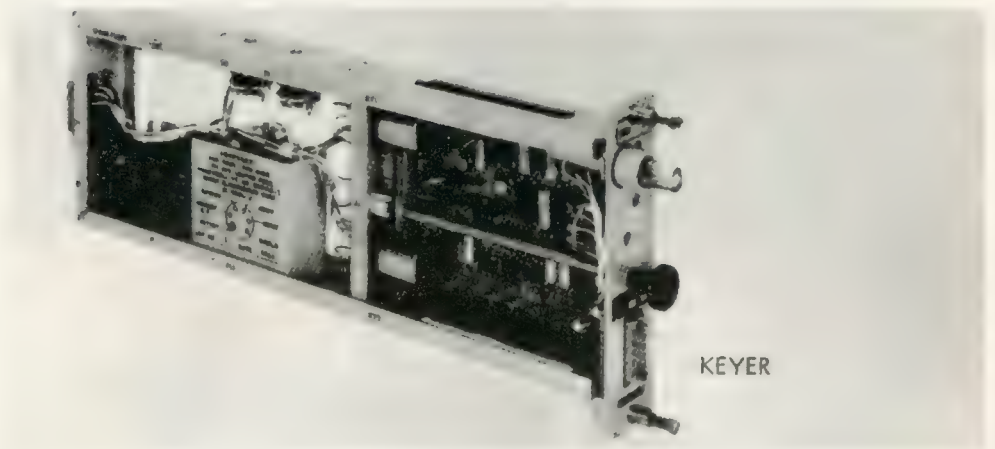
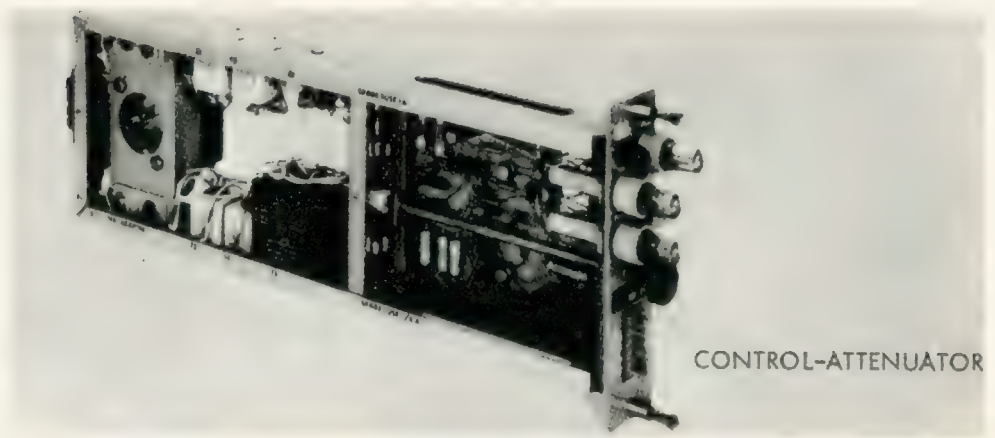


Figure 2. Keyer, Frequency Shift KY-558(P)/UCC-1C(V), Converter, Frequency Shift CV-1920(P)/UCC-1C(V), and Control-Attenuator C-6554/UCC-1C(V)

individual line, and allow connection of either two or four Converters to form diversity combinations. The Converter has its own power supply; all active Converter components are contained on a plug-in printed-circuit card that is interchangeable with cards of other Converters.

CONTROL-ATTENUATOR, C-6554/UCC-1C(V), see figure 2. In the Control-Attenuator line power for the Cabinet-housed Keyers and Converters is fused and switched. The unit has switches that permit:

1. Selection of the Cabinet's mode of operation (master or slave) and
2. Connection of the composite voice-frequency lines to the connectors at the rear of the Cabinet. Each unit also incorporates a constant level amplifier that maintains the composite output power at a constant level when up to sixteen tones having a combined peak power within the range of -24 to +18 dbm are combined. A control on the module panel allows adjustment of the composite output power level.

A removable Test Adapter fixture provides for operation and testing of an individual Keyer, Converter, or Attenuator Module external to and independent of the Cabinet. Transmit group attenuation is available in the Control-Attenuator as described above, and is obtained by adjustment of the output Level Control.

TEST SET, TELEGRAPH, TS-2232/UCC-1C(V), see figure 1. The portable Test Set used for alignment and test of the other Telegraph Terminal units, provides facilities for:

1. Tone-level measurement.
2. Loop-current measurement.
3. Reversals generation (75 or 150 baud).
4. Converter phase-distortion alignment.
5. Audible-signal tracing (with speaker).
6. Mark and Space Tone generation for 16 narrow-band and four wide-band channels

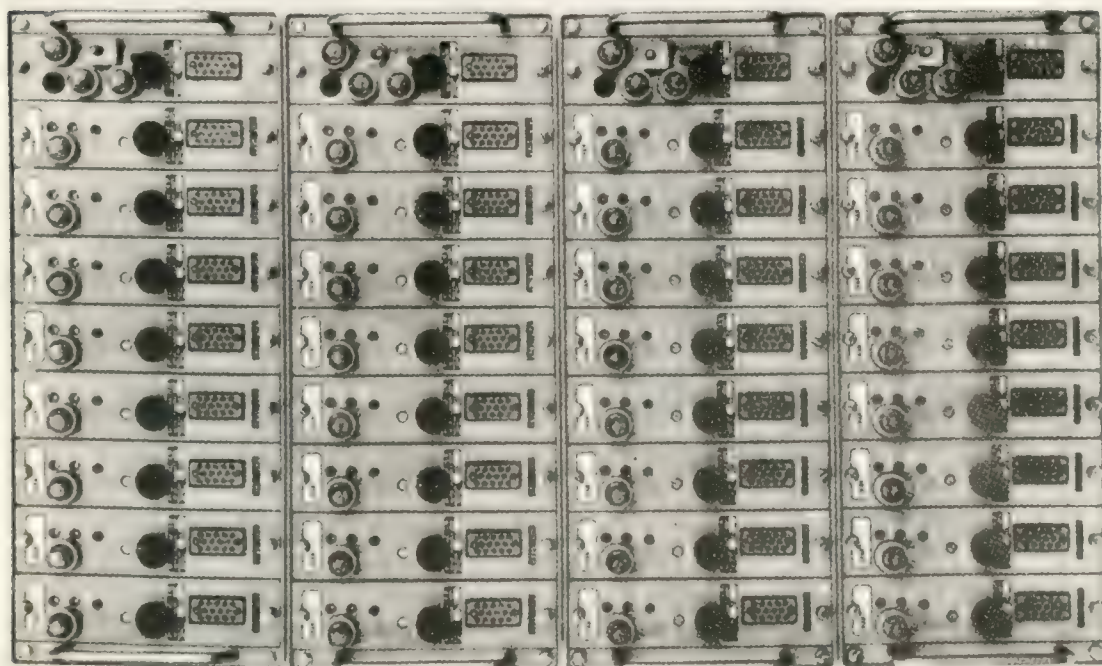
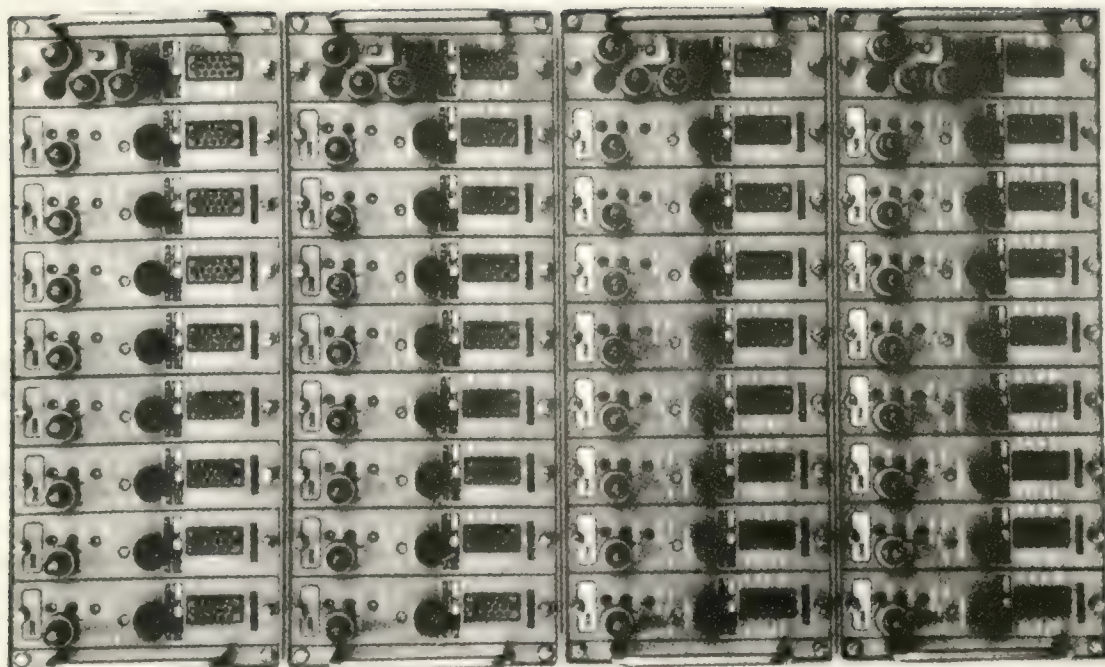
The Test Set contains a panel-mounted d-c microammeter (marked in ma, volts and dbm) and associated switching, a delay-adjustment network used in equalizing the phase delay in individual channels of a receiving diversity combination, a voice-frequency audio amplifier and loud-speaker that gives an audible indication of the v-f signal, a dot-cycle generator that provides electronic keying signals at rates of 75 or 150 baud for alignment of narrow- or wide-band channels, respectively, and a tone generator that generates the appropriate mark and space tones for the 16 narrow-band and four wide-band channels (40 tones total) respectively.

TYPICAL TERMINAL CONFIGURATIONS

A typical terminal configuration, using the Telegraph Terminal units, is illustrated in figure 3.

Telegraph Terminal AN/UCC-1C(V) is modular equipment. Thus the number of units constituting an installation varies, depending upon the specific configuration involved.

To protect the semiconductor circuitry, do not install any telegraph terminal units above, below, or beside any equipment that radiates excessive heat.



Other configurations used are a 16-channel space-diversity or r-f diversity terminal comprising 16 Keyers and 32 Converters (operating in a full-duplex mode) housed in six Cabinets and a 16-channel non-diversity full-duplex terminal comprising 16 Keyers and 16 Converters housed in four Cabinets.

Figure 3 shows a 16-channel frequency-diversity full-duplex terminal. The transmitting combination (left stack) comprises 32 Keyers housed in four Cabinets. A Government-furnished Multiplexer-Demultiplexer used as a multiplexer is not shown. The receiving combination (right stack) comprises 32 Converters housed in four Cabinets. A Government-furnished Multiplexer-Demultiplexer used as a demultiplexer is not shown. The 16-channel frequency-diversity terminal occupies 54 inches of vertical space exclusive of the Multiplexer-Demultiplexers. The configuration can be stacked or placed in one stack with the Multiplexer-Demultiplexers on top.

TYPICAL SYSTEM CONFIGURATIONS

Typical system configurations that can be established using Telegraph terminal units are illustrated in figures 4 through 7.

Figure 4 shows an eight channel frequency-diversity, space-diversity system configuration.

1. At the transmitter site, signals from eight telegraph loops are applied to eight frequency-diversity Keyer pairs housed in two Cabinets. The composite 16-tone output (eight frequency-diversity pairs) is applied to the radio transmitter and sent over a radio link.
2. At the receiver end, two radio receivers, arranged for space-diversity operation, are used to receive the radio signals, in order to obtain improved reception should fading exist at either one of the radio-receiver locations. Each diversity group comprises two frequency-diversity pairs of Converters, one pair per radio receiver. The outputs of the four Converters are compared and are used to key one telegraph loop. Thus, 32 Converters, housed in four Cabinets are used at the receiving end of the radio link.

Figure 5 shows a 16-channel frequency-diversity system, using a 6-kc communication link. The system configuration shown is required to transmit signals from 16 telegraph loops in frequency-diversity, over a single 6-kc communication link, and to receive these signals at the opposite end of the link.

1. At the transmitter end, 32 Keyers, housed in four Cabinets, are used to obtain 16 frequency-diversity pairs. A Government-furnished Multiplexer-Demultiplexer operating as a multiplexer shifts the composite output of eight frequency-diversity pairs to the upper portion of the 6-kc band, combining these on a common line with the unshifted composite signal of the other eight frequency-diversity pairs.

8 DC
TELEGRAPH
LOOPS

CABINET HOUSING
4 FREQ DIVERSITY
PAIRS OF KEYERS;
425~, 1785~;
595~, 2125~;
765~, 1955~;
935~, 2295~.

COMPOSITE 16 -
TONE OUTPUT
(8 FREQ
DIVERSITY PAIRS)

RADIO
TRANSMITTER
(GFE)

RADIO
RECEIVER "A"
(GFE)

COMPOSITE 16 -
TONE OUTPUT
(8 FREQ
DIVERSITY PAIRS)

RADIO
RECEIVER "B"
(GFE)

COMPOSITE 16-TONE
OUTPUT (8 FREQ
DIVERSITY PAIRS)

CABINET HOUSING
2 FREQUENCY/SPACE
DIVERSITY GROUPS OF
CONVERTERS 2 EACH OF
425~, 1785~
AND
595~, 2125~.

CABINET HOUSING
2 FREQUENCY/SPACE
DIVERSITY GROUPS OF
CONVERTERS 2 EACH OF
765~, 1955~;
AND
935~, 2295~.

CABINET HOUSING
2 FREQUENCY/SPACE
DIVERSITY GROUPS OF
CONVERTERS 2 EACH OF
1105~, 2465~;
AND
1275~, 2805~.

CABINET HOUSING
2 FREQUENCY/SPACE
DIVERSITY GROUPS OF
CONVERTERS 2 EACH OF
1445~, 2635~;
AND
1615~, 2975~.

8 DC
TELEGRAPH
LOOPS

Figure 4. Eight-Channel Frequency-Diversity/Space-Diversity System

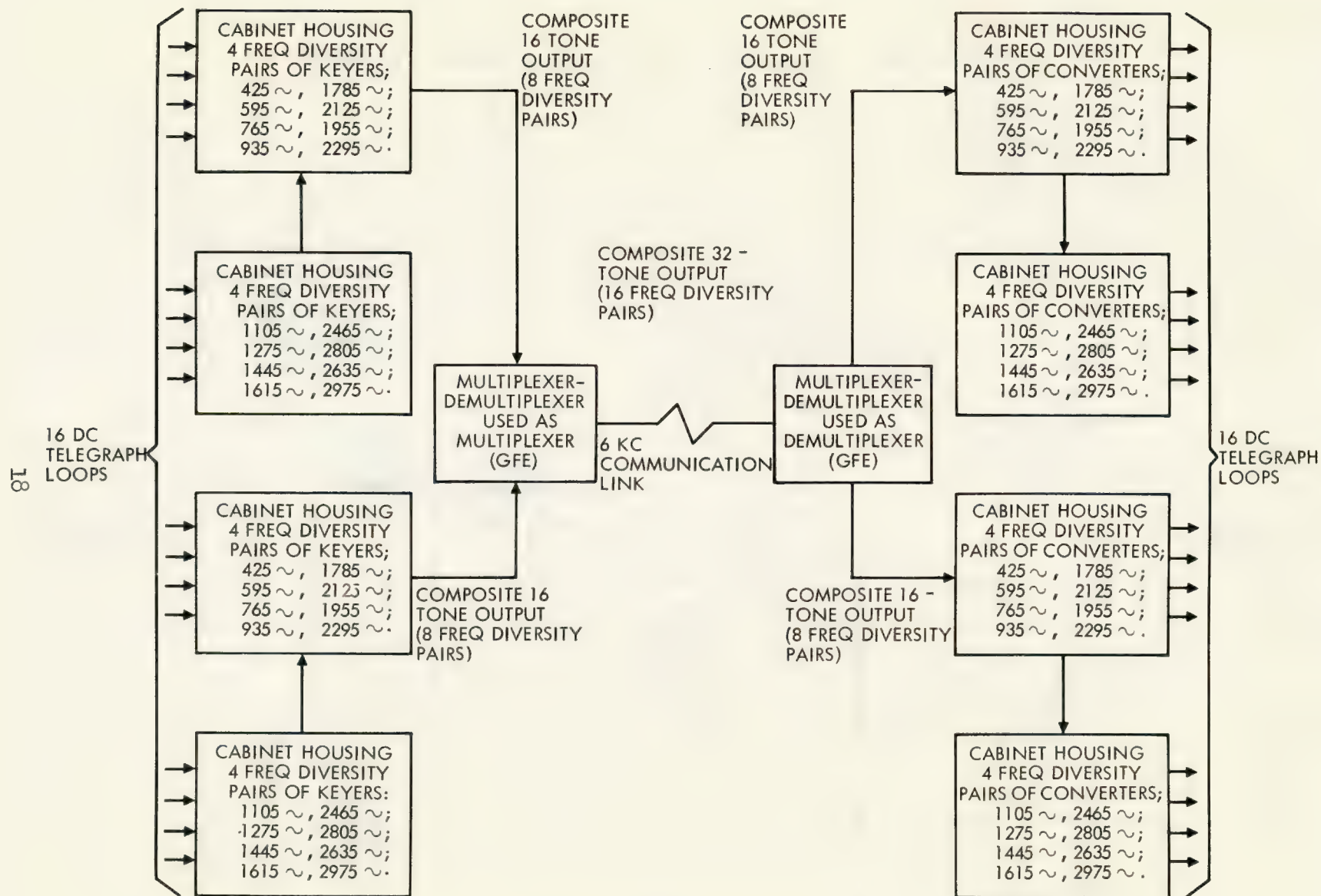


Figure 5. Sixteen-Channel Frequency-Diversity System, Using a Six-KC Bandwidth Communications Link

2. At the receiving end of the link, another Government-furnished Multiplexer-Demultiplexer and 32 Converters, housed in four Cabinets, are used to reverse the process performed at the transmission end and to supply electronic keying for 16 telegraph loops.

Figure 6 shows a six-channel frequency-diversity full-duplex system. at each end of the link, 12 Keyers and 12 Converters are housed in three Cabinets. One Cabinet houses eight Keyers, a second houses four Keyers and four Converters, and a third houses eight Converters.

Figure 7 shows a four-channel frequency-diversity, r-f diversity system.

1. At the transmitting end of the system, eight Keyers, housed in a Cabinet, are arranged to obtain radio transmitters A and B, which broadcast the information to radio receivers A and B, respectively. The radio transmitters and receivers operate on two different frequencies, designated "A" and "B", thus obtaining the system's r-f diversity. R-F diversity operation improves reception in the presence of fading at either one of the r-f signal frequencies.
2. At the receiving station, 16 Converters, housed in two Cabinets, are arranged to obtain four 4-channel frequency-diversity combinations. Each frequency-diversity channel comprises two frequency-diversity pairs, one operated by each of the radio receivers. The outputs of each of the four-channel frequency-diversity combinations key a single d-c telegraph loop.

REFERENCE DATA

KEYING RATE

- | | |
|------------------------|----------------------|
| 1. Narrow-band channel | 75 bauds (nominal). |
| 2. Wide-band | 150 bauds (nominal). |

FREQUENCY STABILITY

(under all operating and environmental conditions).

± 0.5 cps for both mark and space frequencies on all channels.

TELEGRAPH LOOPS

- | | |
|---------------------|-----------------------------------|
| 1. Types of signals | |
| a. Receive loops | Neutral. |
| b. Send loops | Neutral or Polar. |
| 2. Loop current | |
| a. Neutral | 20 or 60 ma. |
| b. Polar | + 30 ma. |
| 3. Loop battery | 120 volts d-c supplied from loop. |

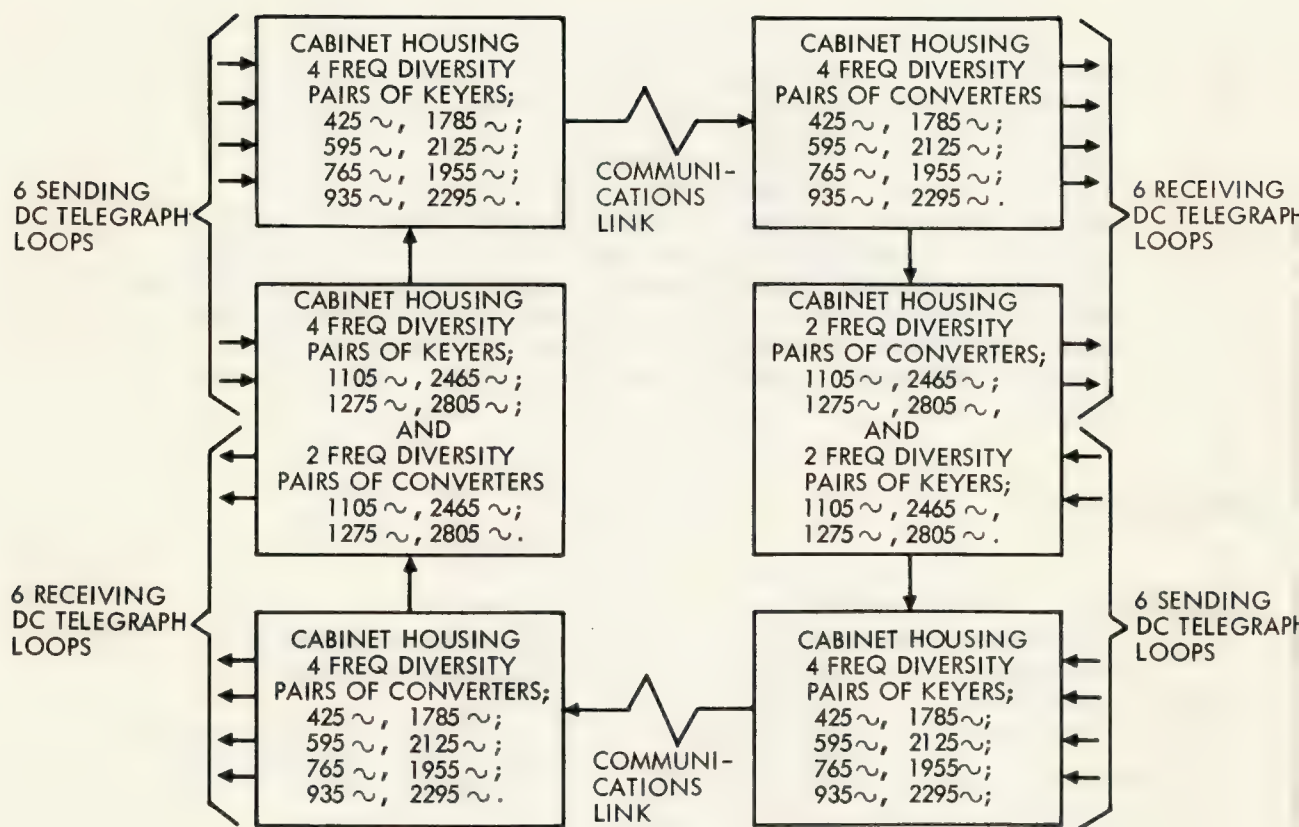


Figure 6-40 Six-Channel Frequency-Diversity System

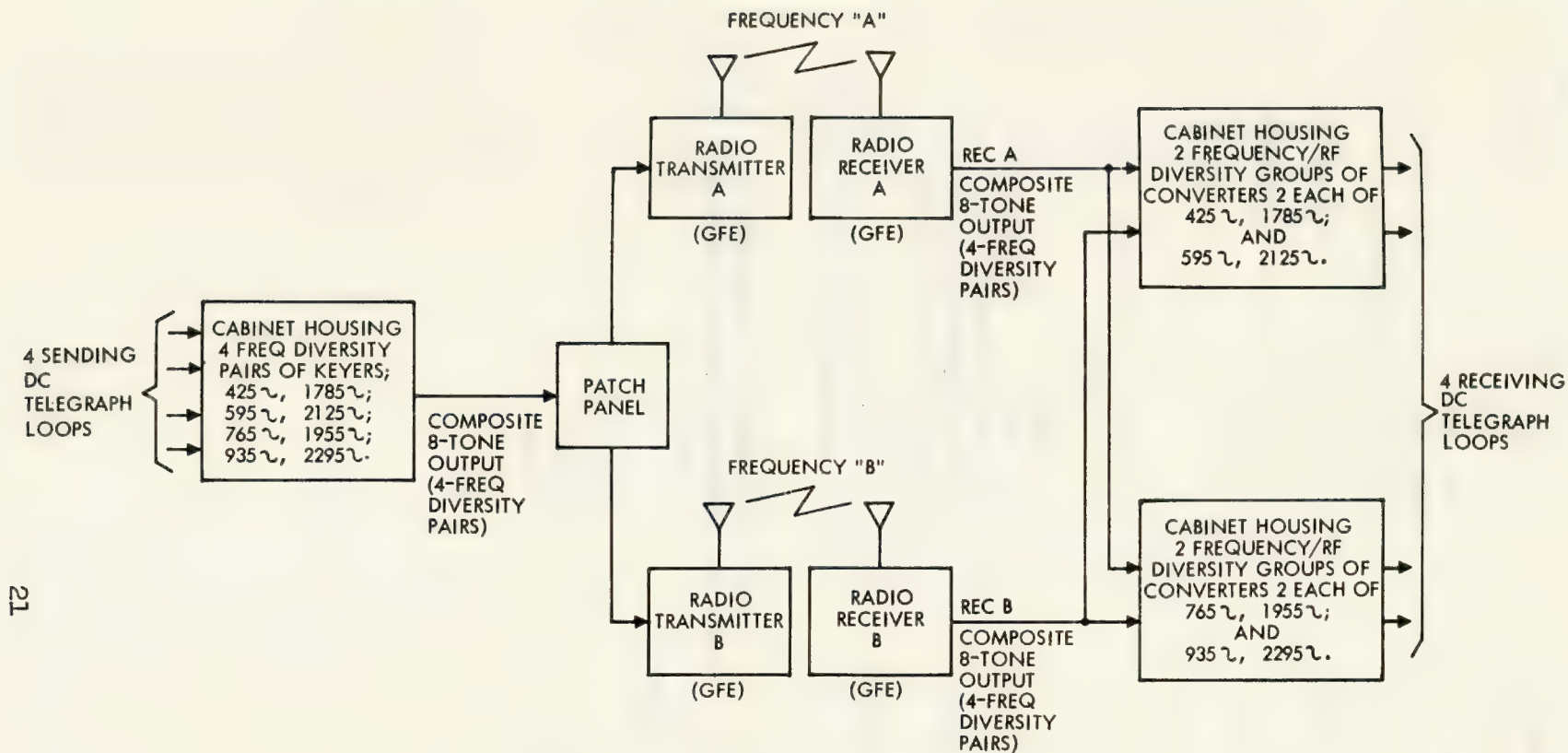


Figure 7. Four-Channel Frequency-Diversity, R-F Diversity System

KEYER

- | | |
|---|---|
| 1. Number of channels per Cabinet | 8. |
| 2. Input resistance | 300 ohms. |
| a. 20 or 30 ma loop | 100 ohms. |
| b. 60 ma loop | 600 ohms, ungrounded, center-tapped. |
| 3. Output termination | -24 to +6 dbm, continuously adjustable. |
| 4. Individual output levels | -38 to +6 dbm, continuously adjustable. |
| 5. Composite, Control-Attenuator output range | |

CONVERTER

- | | |
|--|---|
| 1. Number of channels per Cabinet | 8. |
| 2. Input impedance | 600 ohms, ungrounded, center-tapped. |
| 3. Input levels | +10 dbm. |
| a. Maximum | -40 dbm. |
| b. Minimum | 800 ohms maximum. |
| 4. Output resistance | 2.0 millisecond maximum under all operating conditions. |
| 5. Phase distortion (without adjustment) | 0-3.5 ms delay range. continuously variable. |
| 6. Phase distortion control | |

POWER REQUIREMENTS

- | | |
|--------------------------------|-------------------------------|
| 1. Type | 115/230 $\pm$ 10 percent. |
| a. Voltage | 50 or 60 cps $\pm$ 5 percent. |
| b. Frequency | Single. |
| c. Phase | |
| 2. Power consumption (typical) | 9 watts. |
| a. Keyer | 5.5 watts. |
| b. Converter | 5 watts. |
| c. Control Attenuator | 10 watts. |
| d. Test Set | |

CHANNEL FREQUENCIES. - Table 1 lists the channel frequencies of Telegraph Terminal. Table 2 lists the frequency-diversity combinations.

TABLE 1. Channel Frequencies*

CENTER FREQUENCY CPS	MARK FREQUENCY CPS	SPACE FREQUENCY CPS
425	467.5	382.5
595	637.5	552.5
765	807.5	722.5
935	977.5	892.5
1105	1147.5	1062.5
1275	1317.5	1232.5
1445	1487.5	1402.5
1615	1657.5	1572.5
1785	1827.5	1742.5
1955	1997.5	1912.5
2125	2167.5	2082.5
2295	2337.5	2252.5
2465	2507.5	2422.5
2635	2677.5	2592.5
2975	3017.5	2932.5
**1955	2040	1870
**2380	2465	2295
**2805	2890	2720
**3230	3315	3145

*SIGNAL SENSE switch in NORMAL position. With SIGNAL SENSE switch in REVERSE position, interchange MARK and SPACE frequencies

**Wide-band channels ($\pm$ 85 cps).

TABLE 2. FREQUENCY-DIVERSITY COMBINATIONS*

NARROW-BAND (CPS)		NARROW-WIDE BAND (CPS)
NORMAL COMBINATIONS	NORMAL AND REVERSE** COMBINATIONS	
425-1785	425**-1785	425-1105
595-2125	595**-1955	595-1445
765-1955	765**-2125	765-1275
935-2295	935**-2295	935-1615
1195-2465	1105**-2465	
1275-2805	1275**-2635	
1445-2635	1445**-2805	
1615-2975	1615**-2975	

* These combinations are recommended so that a system utilizing a Telegraph Terminal AN/UCC-1C(V) at one station is compatible with a different Telegraph Terminal at another station in the system.

**To use the NORMAL/REVERSE Diversity Combinations, the SIGNAL SENSE switch on channels 425 cps to 1615 cps must be set to the REVERSE position, and that on channels 1785 cps to 2975 cps must be set to the NORMAL position.

FUNCTIONAL OPERATION.

Telegraph Terminal AN/UCC-1C(V) operates automatically in various types of telegraph transmission systems. It accepts d-c telegraph signals and converts them into voice-frequency signals at the transmission end of a communication link; voice-frequency signals from up to 16 channels are combined on a single communications circuit. At the opposite end of the communication link, the Telegraph Terminal separates the voice-frequency signals and converts them to electronic keying signals for receiving telegraph loops.

The Telegraph Terminal comprises different numbers of modules, as required for specific system configurations and capacities. Transmitting and receiving conversions between telegraph loop keying signals and voice-frequency signals are performed by Cabinet-housed Keyers and the Converters. Switches on the Keyers and Converters determine the system interconnection between the modules. A Test Set provides special meter circuitry, a reversal generator, and a tone generator to aid in adjustment of the Telegraph Terminal.

OPERATING PROCEDURES.

Once the Telegraph Terminal is installed, initial switch setting and adjustments have been made and power is applied, equipment

operation is automatic. Operator attention is not required except for starting and stopping procedures, and for testing equipment operation with the Test Set or auxiliary equipment.

Except for Test Set controls used during operator's maintenance, only the power switch (115VAC/230VAC) is used by the operator. Telegraph Terminal front-panel controls and their functions are listed below:

CONTROL-ATTENUATOR (see figure 8)

1. FUSES - Two 1-ampere fuses which protect the two sides of the a-c line.
2. ATTEN FUSE - A 1/8-ampere fuse which protects the power supply circuit in the Control-Attenuator module.
3. MAIN POWER indicator - Lights to indicate power is on.
4. 115 VAC/230 VAC power switch - Controls and indicates application of line power to modules housed in the cabinet (115 volts or 230 volts depending on the power source, and the internal wiring of the Cabinet).
5. LEVEL control - A screwdriver adjustment for setting the level of Control-Attenuator output signals.
6. TEST connector - Provides a means of connecting Control-Attenuator test points to the Test Set quickly and easily.
7. TONE OUT - Two test points for monitoring the composite parallel-tones transmit signal lead output.
8. RCVR A - Test point for monitoring the composite parallel-tones receive signal applied to the PARALLEL TONES RCVR A connector.
9. RCVR B - Test point for monitoring the composite parallel-tones receive signal applied to the PARALLEL TONES RCVR B connector.
10. +12V - Test point for monitoring the +12V power in the Control-Attenuator.
11. COM - Test point for monitoring common (signal ground) in the Control-Attenuator.

KEYER (see figure 9)

1. FUSES - A 1/8- ampere fuse which protects the power supply circuit in the Keyer module. This fuse is located on the Keyer front panel.
2. BIAS control - A screwdriver adjustment for obtaining zero bias distortion of the voice-frequency signal. Can be detected as either an average frequency equal to the channel center frequency on a frequency counter or as a symmetrical square wave when monitoring the Bias test point with an oscilloscope.
3. TONE Control - A screwdriver adjustment for obtaining the required output power level (monitored at TONE test points with either the Test Set or auxiliary equipment).
4. TONE switch - A screwdriver actuated switch for removing the v-f output of the Keyer from the composite tone line.
5. DIVERSITY switch - A screwdriver actuated switch for monitoring the d-c input loop diversity combination.



Figure 8. Control-Attenuator, Front Panel



Figure 9. Keyer, Front Panel

6. TEST connector - Provides a means of connecting Keyer test points to the Test Set quickly and easily.
7. +LOOP/-LOOP - Two test points for monitoring the d-c input loop current by determining the voltage drop across an internal 82 ohm resistor. The -LOOP test point is connected to Keyer circuit ground (common).
8. +3V/+12V/-6.8V - Three test points for monitoring the output voltage levels of the Keyer power supply circuits.
9. TONE OUT - Two test points for monitoring tone output level.
10. COM - Test point connected to common (circuit ground).
11. BIAS - Test point for monitoring the symmetry of the output of the Schmitt-trigger circuit that controls the switching of the mark and space oscillators.

CONVERTER (see figure 10)

1. FUSE - 1/8-ampere fuse which protects the power supply circuit in the converter module. This fuse is located on the front panel.
2. BIAS control - A screwdriver adjustment for obtaining zero bias distortion in the d-c output loop.
3. DELAY control - A screwdriver adjustment for equalizing system delays by varying the time delay through the input filters.
4. DIV BAL - A screwdriver adjustment for equalizing the gain of the AGC amplifiers when operating in the diversity mode.
5. DIVERSITY switch - A screwdriver actuated switch for setting the converter interconnections for individual diversity (two-channel or four-channel) operation.
6. TEST connector - Provides a means of connecting Converter test points to the test Set quickly and easily.
7. +LOOP/-LOOP - Two test points for monitoring the d-c output loop current by determining the voltage drop across an internal 82-ohm resistor.
8. +12V - Test point for monitoring the output voltage level of The converter power supply circuit.
9. AGC - Test point for monitoring the output level of the AGC amplifier.
10. DISC A/DISC B - Two test points for monitoring the floating output of the discriminators. (The ground lead of the oscilloscope should be connected to DISC B.)
11. BAL - Test point for monitoring the input to the discriminator.
12. COM - Test point connected to common (circuit ground).
13. TONE IN - Test point for injecting a signal to the AGC circuits to test the performance of the internal circuitry.

TEST SET (see figure 11)

1. FUSES/LINE 1/8 A - Protect the Test Set power supply circuit.
2. POWER indicator - Lights to indicate power is on.
3. 115V/230V power switch - Controls and indicates application of line power to Test Set (115volts or 230volts depending on the power source and the position of the locking guard).
4. READ/IND switch - Operates in conjunction with the FUNCTION SELECTOR switch to determine the function of the panel meter. In IND position, and indication within the green band is acceptable; in READ position, actual values are measured.



Figure 10. Converter, Front Panel

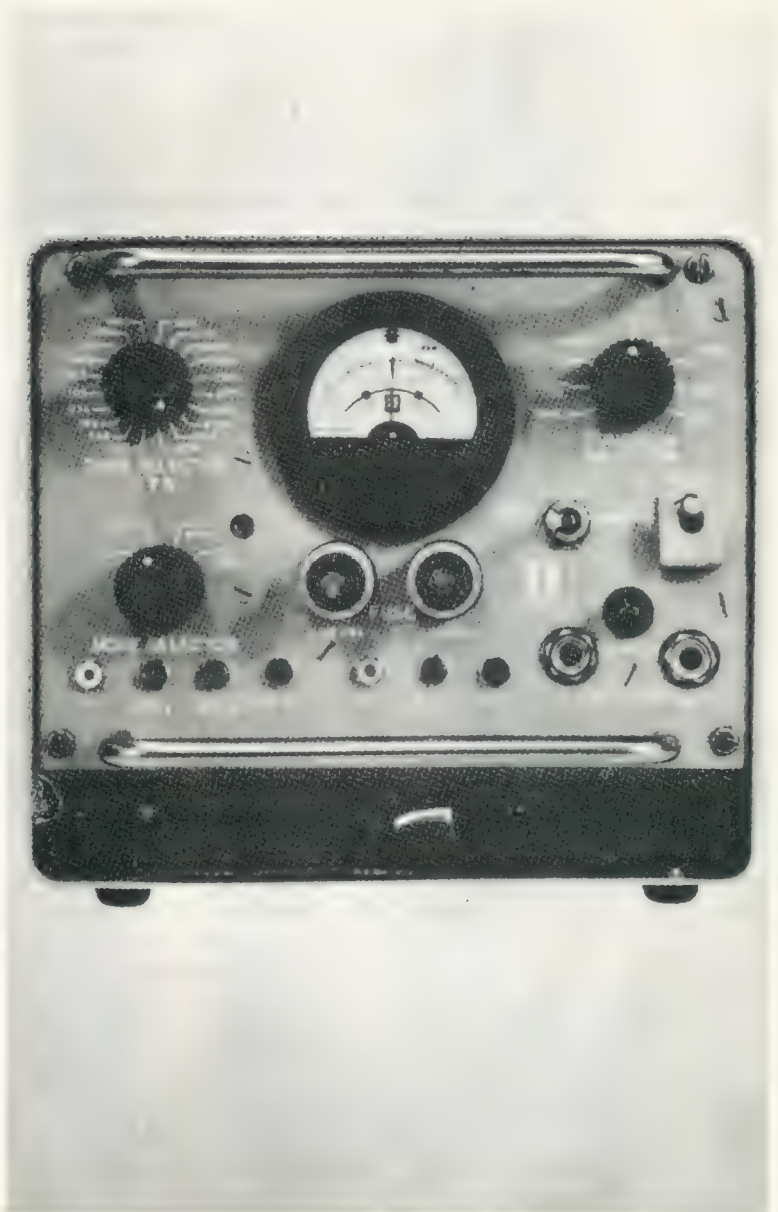


Figure 11. Test Set, Front Panel

5. FUNCTION SELECTOR switch - Connects Telegraph Terminal functions from test cable to panel meter. The meaning of the panel meter indication depends upon the position of the READ/IND switch for each position of the FUNCTION SELECTOR switch, as follows
- A. TONE IN position - Connects tone from module to meter circuit and loud speaker.
 - 1. READ position is the actual level of the input signal and is indicated on the DBM scale of the panel meter.
 - 2. IND position is a zero dbm + 2 db input signal is indicated by a meter reading within the green band.
 - B. LOOP CUR. position - D-C loop current is determined by measuring the voltage drop across an 82-ohm resistor located in the module being tested. (The resistor is provided in each module.)
 - 1. READ position - Actual value of the loop current is indicated on the panel meter at a sensitivity of 100 ma full scale.
 - 2. IND position - A loop current of 60 ma + 5 ma produces a meter indication within the green band.
 - C. +12V position - Connects the +12 volt power supply in the module being tested to the panel meter voltage measuring circuit.
 - 1. READ position - Actual value of the voltage is indicated on the panel meter at a sensitivity of 20 volts full scale.
 - 2. IND position - A power supply of +12 volts +5 percent produces a meter indication within the green band.
 - D. -6.8V position - Connects the -6.8-volt power supply (Keyer module only) to the panel meter voltage measuring circuit.
 - 1. READ position - Actual value of the voltage is indicated on the panel meter at a sensitivity of 10 volts full scale.
 - 2. IND position - A power supply of -6.8 volts +5percent produces a meter indication within the green band.
 - E. +3V position - Connects the +3-volt power supply (Keyer module only) to the panel meter voltage measuring circuit.
 - 1. READ position - Actual value of the voltage is indicated on the panel meter at a sensitivity of 10 volts full scale.
 - 2. IND position - A power supply of +3 volts +5 percent produces an indication within the green band.
 - F. PHASE/LO position - Connects output of phase-adjustment measurement network to panel meter through series resistance for low-sensitivity indication.
 - G. PHASE/HI position - Connects output of phase-adjustment measurement network to panel meter for high-sensitivity indication.

- H. TONE OUT position - Provides a steady tone for aligning Converter modules at the channel frequency selected by the TONE SELECTOR switch and at either the mark or space frequency as selected by the MODE SELECTOR switch.
- I. REV. OUT position - Provides a d-c loop current for triggering a Keyer module as selected by the MODE SELECTOR switch.
- J. MODE SELECTOR switch - This switch selects the mode of the tone or reversals output depending on the position of the FUNCTION SELECTOR SWITCH.
 - 1. MARK position - Provides a steady mark current to a Keyer module when the FUNCTION SELECTOR switch is in the REV. OUT position and provides a steady mark frequency for the channel selected by the TONE SELECTOR switch when the FUNCTION SELECTOR switch is in the TONE OUT position.
 - 2. SPACE position - Provides a steady space signal to a Keyer module when the FUNCTION SELECTOR switch is in the REV. OUT position and provides a steady space frequency for the channel selected by the TONE SELECTOR switch when the FUNCTION SELECTOR switch is in the TONE OUT position.
- K. 150 BAUD position - Provides alternate d-c marks and spaces (dot-cycle) from the reversals generator to a Keyer module at 150 baud when the FUNCTION SELECTOR switch is in the REV. OUT position.
- L. 75 BAUD position - Provides alternate d-c marks and spaces (dot-cycle) from the reversals generator to a Keyer module at 75 baud when the FUNCTION SELECTOR switch is in the REV. OUT position.
- 6. TONE SELECTOR switch - Provides a steady tone to a Converter module at either the mark frequency or the space frequency (determined by the MAKE SELECTOR switch) when the FUNCTION SELECTOR switch is in the TONE OUT position.
- 7. AGC jack - A test jack for monitoring the AGC test point of a Converter when the test cable is plugged into the TEST connector of the Converter. In effect, extends the AGC testpoint to the front panel of the Test Set.
- 8. DISC A/RCVR A jack - A test jack for monitoring the DISC A test point of a Converter or the RCVR A test point of a Control-Attenuator when the test cable is plugged into the TEST connector of the module. In effect, extends the DISC A or RCVR A test point to the front panel of the Test Set.
- 9. DISC B/RCVR B jack - A test jack for monitoring the DISC B test point of a Converter or the RCVR B test point of a Control-Attenuator when the test cable is plugged into the test connector of the module. In effect, extends the DISC B or RCVR B test point to the front panel of the Test Set.
- 10. DIV BAL jack - A test jack for monitoring the BAL test point of a Converter when the test cable is plugged into the TEST connector of the Converter. In effect, extends the BAL point to the front panel of the Test Set.
- 11. SYM jack - A test jack for monitoring the BIAS test point of a Keyer when the test cable is plugged into the TEST connector of the Keyer. Used for adjustment of Keyer symmetry.

12. PHASE ADJ jack - A test jack for connecting the +LOOP test point of one Converter (Pin A) to the Test Set while the test cable is plugged into the Test connector of another Converter to permit phase comparison for the delay adjustment for diversity operation.
13. COM. jack - A test jack for circuit ground (the COM test point) of a module or of other test equipment to circuit ground of the Test Set.
14. AMPLIFIER IN jack - A telephone jack connected to the input of the signal tracing amplifier in the Test Set.
15. AMPLIFIER OUT jack - A telephone jack connected to the output of the signal tracing amplifier in the Test Set for operation with 500 or 1000 ohm headphones.

SEQUENCE OF OPERATION. - The operating procedures for the equipment are the procedures for starting and stopping the equipment. once started, the equipment requires no operator attention, except for the maintenance procedures and Test Set applications described above.

STARTING PROCEDURE.

1. Set the power switch on the Control-Attenuator in each Cabinet to the on position (115 VAC or 230 VAC depending upon the power source).
2. Make sure that the MAIN POWER indicator lights and that none of the fuse indicators, on the front panels of the modules in the cabinet, light.

NOTE

If the Test Set is to be used, set its power switch to 115V or 230 VAC depending on the power source, and make sure that the LINE FUSE indicator does not light.

STOPPING PROCEDURE.

Set the power switch (marked 115 VAC/230 VAC) on the Control-Attenuator in each Cabinet to the off (center) position. (If the Test Set is in use, set its power switch to the off position.) This procedure applies also in emergencies

OPERATING CHECKS.

The Telegraph Terminal operates automatically, requiring attention, or maintenance by the operator only in cases of malfunction.

The following quick checks may be used at the start of the operating period to assure proper operation. If they are performed correctly, the quick check may be used to verify correct operation.

NOTE

Before plugging the test cable of the TEST connector of a module, make sure that the FUNCTION SELECTOR switch of the Test Set is in the correct position. If it is in the wrong position, signals from the Test Set will interrupt the operation of the Telegraph Terminal.

KEYER CHECKS.

See figure 9, set the FUNCTION SELECTOR switch of Test Set to LOOP CUR.

Plug the test cable of the Test Set into the TEST connector of the Keyer module and observe that the meter indicates the current given in either 1 or 2 below:

- 1 Either 20 ma or 60 ma with the Keyer input in the steady marking condition. The current depends on the external loop supply.

- 2 Either 10 ma or 30 ma with a reversal signal applied to the Keyer.

Set the FUNCTION SELECTOR switch to TONE IN and check for the indications given in 1 and 2 below:

- 1 A meter indication of approximately zero dbm.

- 2 Either a steady audible tone which indicates application of a steady marking or spacing bias, or a variable tone, which indicates application of a reversal signal.

NOTE

The tone frequency depends on the channel frequency.

CONVERTER CHECKS.

See figure 10, connect the Test Set to the Converter using a patch cord with a telephone jack on one end and two tin probes on the other end, as follows:

- 1 Insert the telephone plug into the AMPLIFIER IN jack on the front panel of the TEST SET.
- 2 Insert the ground tin probe into the COM test point of the Converter test connector.
- 3 Insert the signal tin probe into the AGC test point of the Converter test connector.

Observe a meter deflection and listen for a varying audible tone indicating that a frequency-shift keyed (FSK) signal is being applied to the Converter. The frequency of this tone depends on the channel frequency.

NOTE

If the Converters are operating in a diversity combination, only the Converter with the strongest signal level will indicate a tone.

Remove the patch cord and connect the TEST SET test cable to the Converter test connector.

Set the FUNCTION SELECTOR switch of the Test Set to LOOP CUR., and check for the current given in either 1 or 2 below:

- 1 Either 20 ma or 60 ma with the Converter in the steady marking condition. The current depends on the external loop supply.
- 2 Either 10 ma or 30 ma if a reversal signal is being applied to the Converter.

NOTE

If the Converters are operating in a diversity combination, a meter indication will be obtained only from the output Converters. The output Converters for two-channel diversity are located in Cabinet stations A1, A3, A5, or A7. The output Converters for four-channel diversity are located in Cabinet stations A1 or A5.

NOTE

This test applies only if the Control-Attenuator is being used in conjunction with Keyer modules.

Connect the Test Set test cable to the Control-Attenuator TEST connector.

Set the FUNCTION SELECTOR switch of the Test Set to TONE IN and check for the indications given in 1 and 2 below:

1 A meter indication of approximately zero dbm.

2 Either a steady audible tone which indicates application of a steady marking or spacing bias, or a variable tone which indicates application of a reversal signal.

DEFECTIVE CONVERTER.

A defective Converter can be replaced by one (of the same channel frequency) known to be operative. Replace a defective Converter Front Chassis Assembly with any Converter Front Chassis Assembly known to be operative.

DEFECTIVE CONTROL-ATTENUATOR.

A defective Control-Attenuator can be replaced by any other Control-Attenuator known to be operative. Replace a defective Control-Attenuator Front Chassis Assembly with any Control-Attenuator Front Chassis Assembly known to be operative.

ADJUSTING THE TS-2232 TEST SET REVERSAL GENERATOR

INTRODUCTION

Adjusting the reversal generator is a maintenance routine performed on the test set. The reversals signal from the test set is used for adjusting and testing keyer modules.

EQUIPMENT

AN/USM-117 Oscilloscope or equivalent

REFERENCE

NAVSHIPS 0967-046-9010 Technical Manual for Telegraph Terminal AN/UCC-1C(V), page 5-2, paragraph 5-6.

JOB STEPS

Step 1. Complete steps a through e of paragraph 5-6.

Step 2. Plug in test set and turn on power.

Step 3. Complete step f of paragraph 5-6.

Step 4. Have instructor check work before proceeding. Initial_____

Step 5. Complete steps g and h of paragraph 5-6.

Step 6. Have instructor check work before proceeding. Initial_____

Step 7. Turn off power, unplug test set and disconnect oscilloscope.

Step 8. Complete step i of paragraph 5-6.

SELF-TEST ITEMS

The following self-test items have been developed to help you determine how well you understand the maintenance routine described in the job sheet and related information. Place a circle around the letter preceeding the correct answer.

1. For the reversal generator, the condition defined as "zero bias error" occurs when the
 - a. amplitude of mark and space voltages are the same.
 - b. duration of the mark voltage is between 6.0 and 7.5 millisec.
 - c. duration of both voltages are between 6.0 and 7.5 millisec.
 - d. duration of mark and space voltages are the same.

2. The amplitude of the reversals waveform should be
 - a. 6.0 to 7.5 volts.
 - b. at least 8 volts.
 - c. 12.5 to 16.6 volts.
3. The duration of a mark voltage excursion of the 150 baud reversals waveform should be
 - a. 12.5 to 16.6 milliseconds.
 - b. 6.0 to 7.5 milliseconds.
 - c. 8.0 milliseconds.
4. The duration of a mark voltage excursion of the 75 baud reversals waveform should be
 - a. 12.5 to 16.6 milliseconds.
 - b. 6.0 to 7.5 milliseconds.
 - c. 8.0 milliseconds.
5. The FUNCTION SELECTOR switch must be set to some other position than REV OUT before plugging the test connector into a keyer which is transmitting a message because
 - a. the fuse would blow.
 - b. the reversal signal would cause interference and interrupt transmission.
 - c. the reversal generator would be damaged.

AN/UCC-1C(V) INTEGRATED CIRCUIT DEVICES

STUDY ASSIGNMENT

INFORMATION SHEET 1-N4-2-11, Integrated Circuit Devices, Construction and Functioning

NAVSHIPS 0967-046-9010, Technical Manual for Telegraph Terminal AN/UCC-1C(V), pages 4-1 through 4-6.

STUDY QUESTIONS

1. Name four different components that are included in integrated circuits.

2. Explain how N and P type crystal layers are produced by the epitaxial growth process.

3. Explain thermal compression bonding and how it is used in integrated circuits.

4. Name the two basic types of integrated circuit devices used in the AN/UCC-1C(V).

5. Explain how the gain of a differential amplifier is controlled.

6. What is the purpose of the Schmitt trigger?

7. Why is it necessary to use two transistors in series in the crystal controlled oscillator?

8. List the circuit configurations for which the differential amplifier integrated circuit device is used in the AN/UCC-1C(V).

9. What is the purpose of the flip-flop integrated circuit device in the AN/UCC-1C(V)?

INTEGRATED CIRCUIT DEVICES

INTRODUCTION:

This information sheet has been prepared to provide information about the construction and functioning of integrated circuit devices beyond that contained in the technical manual. It does not pretend to be an exhaustive treatment of this very complex subject but is intended primarily for the purpose of explaining terms used to describe the construction of these devices.

REFERENCES:

Warner, Raymond M. Jr., and Fordemwalt, James N., Integrated Circuits, Design Principles and Fabrication, Motorola Series in Solid-State Electronics: New York, McGraw-Hill Book Company, 1965.

NAVSHIPS 0967-046-9010, Technical Manual for Telegraph Terminal AN/UCC-1C(V), pages 4-1 through 4-4.

INFORMATION:

Integrated circuits are essentially descendants of transistors. Reference 2 above describes the operation of the two types of integrated circuit devices used in Telegraph Terminal AN/UCC-1C(V) and shows schematic diagrams of these circuits. Notice that each device consists of a number of transistor sections interconnected with other electronic components (resistors and conductors) to form a complete functional circuit. Other electronic components such as diodes and capacitors of small value can be included in integrated circuits which require them. It is generally known that transistors may be made of either germanium or silicon crystals. Integrated circuits are made only of silicon crystals. These crystals are grown or manufactured by a process commonly called "crystal pulling."

Crystal Pulling

A quantity of extremely pure silicon and any "doping" impurity to be included in the crystal are melted in a crucible. The temperature is stabilized just above the melting point of the silicon. A small seed crystal of pure silicon is lowered until it touches the surface of the molten silicon and then is slowly raised pulling a single crystal from the melt. Typically the pulled crystal is about one inch in diameter and about 8 to 10 inches long. This crystal is cut into thin wafers with a diamond saw. The wafers are lapped and polished to a mirror surface with diamond dust in preparation for the junction-forming processes of epitaxy or diffusion. Each wafer will be processed as a whole forming as many as several hundred integrated circuits which will be separated just before being sealed in their enclosures.

Doping

Doping is the addition of specific N-type or P-type impurities to a semiconductor material to give it the desired electrical characteristics. Doped silicon may be either N-type or P-type. Impurities introduced for doping include boron, phosphorus, antimony, and arsenic.

Epitaxy

Epitaxy or epitaxial growth is a process for continuing the crystalline growth of the wafer or substrate. In this process a thin layer of silicon crystal is grown on the surface of the wafer from a gaseous silicon compound at temperatures in the range of 1000 to 1200 degrees C. Doping impurities are added in the epitaxial process to produce the desired N or P type crystal layers. If the epitaxial layer is the same type as the substrate (wafer) it will differ in the concentration of impurities. Frequently it is of the opposite type producing a PN junction. Figure 1 illustrates epitaxial growth.

Diffusion

Diffusion is a process used to form PN junctions by doping a layer of the crystal substrate. Diffusion works from the outside of the crystal forcing the impurities to penetrate a layer of the substrate instead of including them in a crystal growth process as in epitaxy. The surface of the substrate may be coated with the impurities by a process such as vacuum evaporation. In this process crystals and a small amount of the impurity are placed in a nearly perfect vacuum. The impurity is evaporated by a sudden intense heat causing it to form a thin coating on all surfaces exposed to the vacuum including the exposed surfaces of the crystals. The crystals are then exposed to high temperature in an oven and the impurities are driven (diffused) into the surface of the substrate. Diffusion may also be accomplished by passing a gas containing the impurities over the crystals in a hot oven. Figure 2 presents a series of cross-sections showing the various steps involved in making an integrated circuit transistor section by the diffusion process.

Masking

Masking is a process used to permit diffusing the doping impurities into specific areas only of the wafer. The first step in masking is oxidation of the surface of the wafer. This is accomplished in a diffusion furnace or oven at a temperature of about 1000 degrees C by passing steam or pure oxygen over the surface of the crystals. This causes a chemical reaction changing the silicon of the surface to silicon dioxide which is resistant to diffusion by certain doping impurities. At the conclusion of this step the entire surface is coated with diffusion-resistant silicon dioxide. It is next necessary to make windows or openings through this coating to permit diffusion into specific areas of the wafer. This is accomplished by oxide photolithographic etching.

Oxide Photolithographic Etching

Photolithographic etching is a process by which acid is used to etch a pattern into a material working from a photographic master (negative).

This process is used in photoengraving (the preparation of printing plates) and the fabrication of printed circuit cards. The first step is preparation of a photographic negative of the pattern to be etched into the surface. The second step is coating the surface to be etched with a photographic emulsion called photo resist. The emulsion is polyvinyl alcohol which is soluble in solvents such as trichloroethylene. The dissolved liquid emulsion is spread evenly on the surface and allowed to dry as the solvent evaporates. At this point the substrate and its emulsion coating are, in effect, a photographic plate ready for exposure. The negative is next placed over the emulsion and it is exposed to high-intensity ultraviolet light. The ultraviolet light polymerizes the polyvinyl alcohol emulsion where it passes through the negative making the emulsion virtually impossible to dissolve. Polymerization is the chain-linking of molecules of a substance; this is the process by which plastic resins set up (change from a liquid to a solid). The substrate is next thoroughly rinsed in solvent removing the unexposed areas of the emulsion. It is in these unexposed areas that the etching will occur. Next the wafers are baked in a low-temperature oven to harden the remaining photo resist and immersed in a hydrofluoric acid solution which dissolves the exposed silicon dioxide leaving the windows for the diffusion process. The final steps before diffusion are removal of the photo resist by mechanical abrasion and thorough cleaning. When transistors or transistor sections of integrated circuits are being manufactured, the entire process must be repeated after the first diffusion to form another junction by diffusion.

Deposition

A variety of materials may be deposited on the surface of the wafer for a variety of reasons. Deposition may be used to provide conductors, resistors, dielectric areas, and capacitors of limited capacitance range. Reference 2 shows that the integrated circuits used in the AN/UCC-1C(V) consist of a number of transistor sections interconnected by conductors and resistors. Deposition may be accomplished by a wide variety of processes including vacuum evaporation, various plating techniques, and silk screening. One of several masking techniques is used to assure that the deposited material is the right size and shape, and is in the right place. To fasten lead wires to the transistor or integrated circuit, it is necessary to have metallic coatings on the silicon to bond or braze them to. These coatings are put on the silicon by some form of deposition.

Scribing and Cleaving

Remember that each wafer or substrate may contain up to several hundred integrated circuits at the conclusion of the semiconductor and circuit manufacturing processes. They must be separated into individual integrated circuits and they must be packaged in their enclosures before the integrated circuit devices are complete. The most common method of separating them is scribing and cleaving. The wafer is placed in a jig and lines are scribed between the circuits with a diamond-tipped scribing tool. The individual circuits or dice are then removed from the wafer by applying pressure. This is called cleaving.

Thermal Compression Bonding

Sometimes called thermocompression bonding, this process is commonly used for attaching the lead wires to the deposited film on the semiconductor material. In this process the two metal surfaces to be joined are pressed together at an elevated temperature with sufficient force to deform at least one of them. It is similar to spot welding.

Packaging

The finished semiconductor or die is fastened to the header for the enclosure with solder or a low-temperature blasing alloy. The leads of the semiconductor are welded to the leads of the device which extends from the header with a miniature spot welder. The can is then welded to the header forming an enclosure which is hermetically sealed. It is frequently filled with an inert gas.

NOTE: IMPURITY (BORON) ATOMS ARE TRAPPED IN THE FILM AS IT GROWS

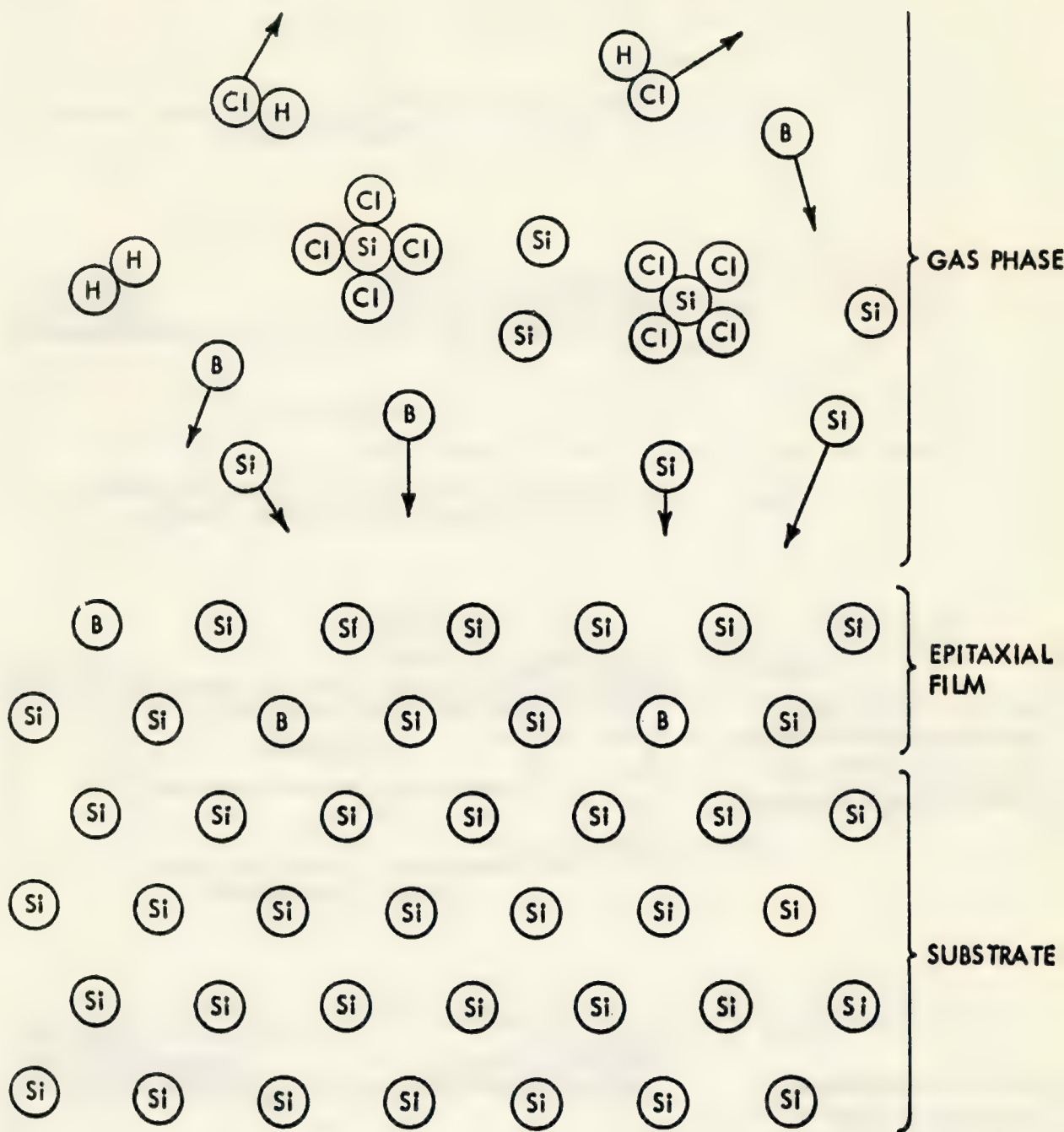
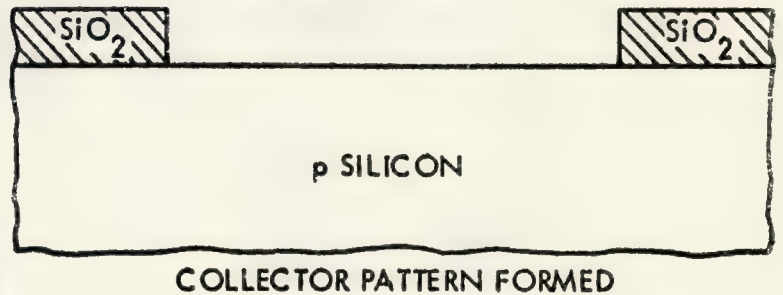
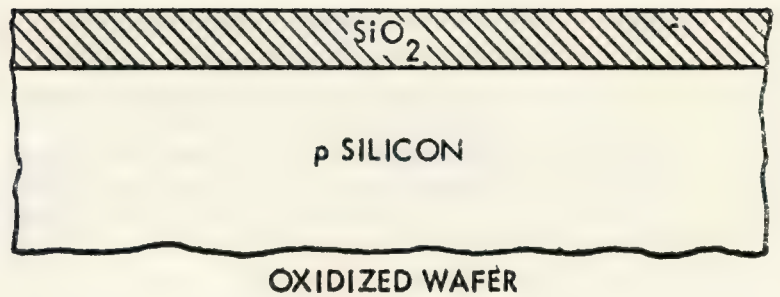
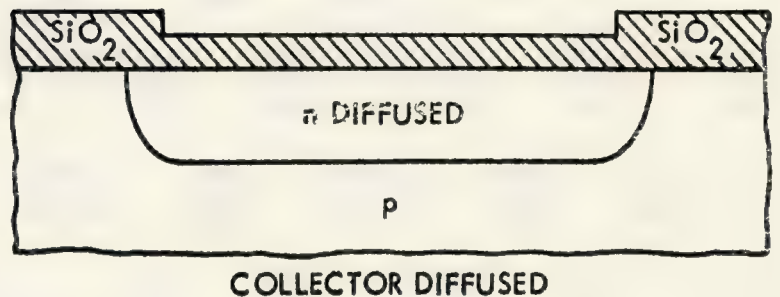


Figure 1. Epitaxial Growth



NOTICE THAT IN EACH
DIFFUSION STEP A LAYER
OF SILICON DIOXIDE IS
FORMED ON THE SURFACE



PHOTOLITHOGRAPHIC
ETCHING IS USED TO
PREPARE THE WAFER FOR
THE NEXT DIFFUSION.

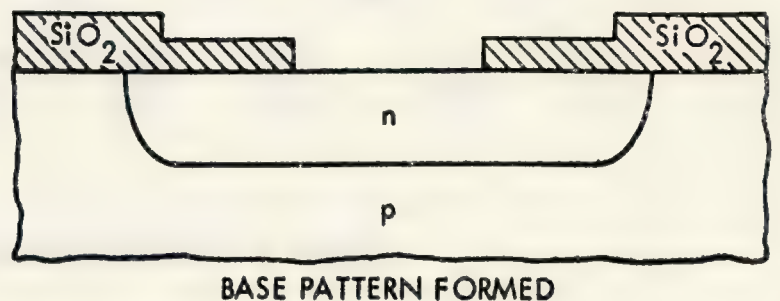
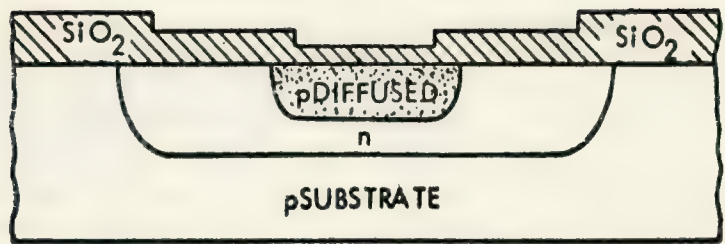
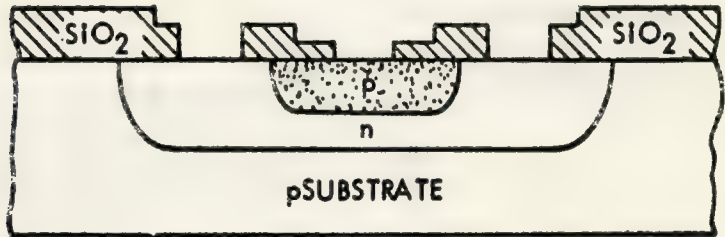


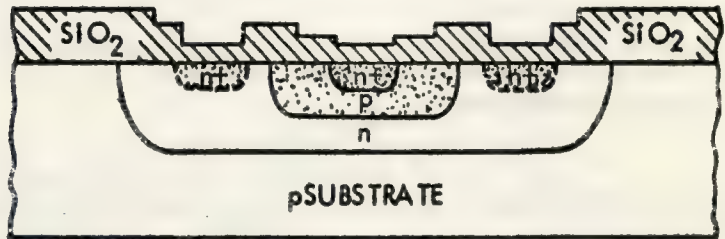
Figure 2. Steps of Manufacture for a Transistor Using the Diffusion Process



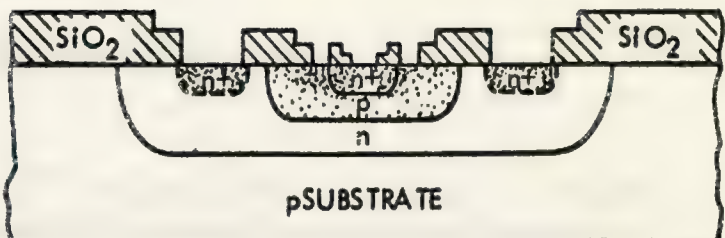
BASE DIFFUSED WAFER



EMITTER PATTERN FORMED



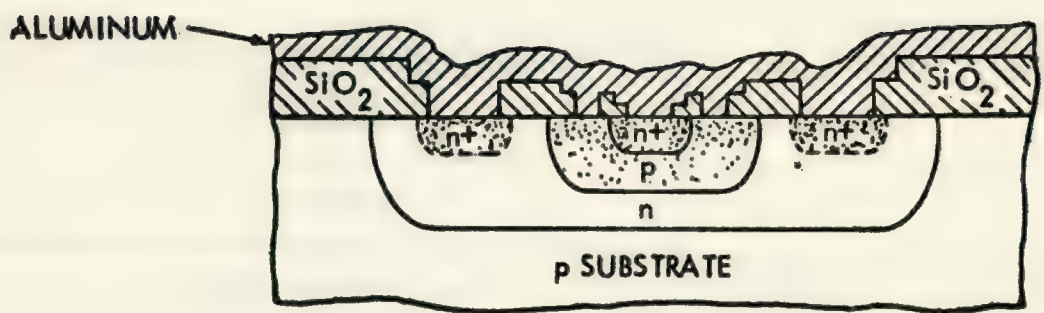
EMITTER DIFFUSED WAFER



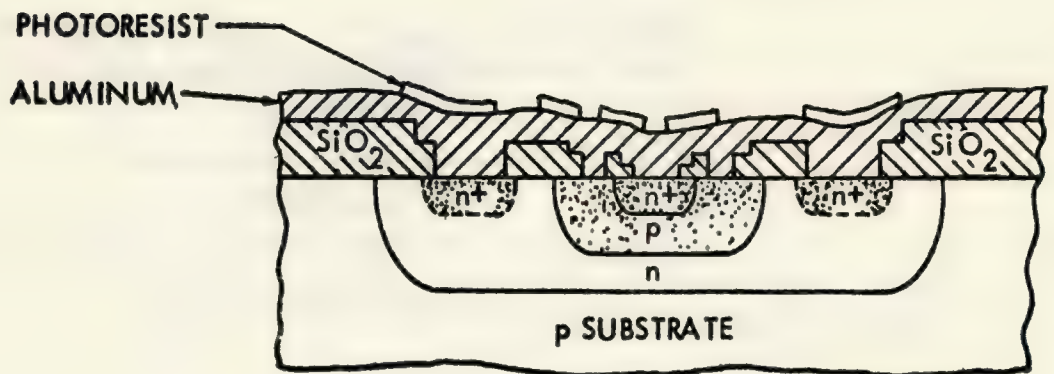
PRE-OHMIC PATTERN FORMED

THE SILICON DIOXIDE
(DIELECTRIC) IS REMOVED
FROM CONTACT AREAS
BY PHOTOLITHOGRAPHIC
ETCHING

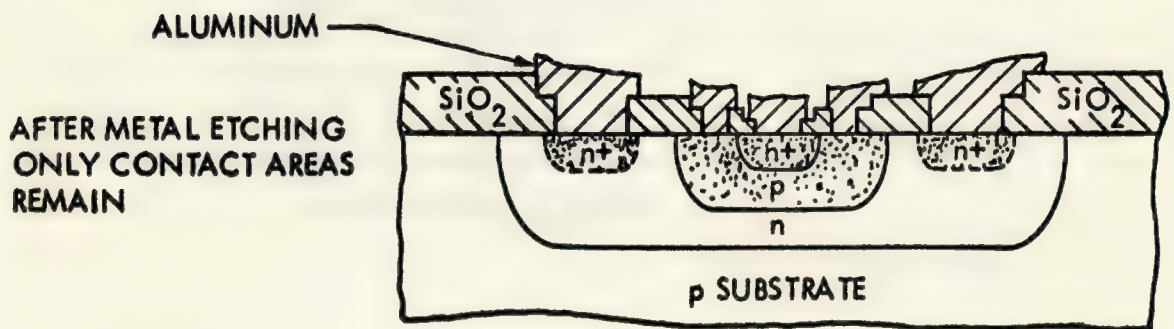
**Figure 2. Steps of Manufacture for a Transistor
Using the Diffusion Process (Continued)**



CONTACT METAL DEPOSITED



PREPARED FOR METAL ETCHING



SEPARATE CONTACT AREAS FORMED

**Figure 2. Steps of Manufacture for a Transistor
Using the Diffusion Process (Continued)**

PRINCIPLE OF OPERATION OF THE AN/VCC-1C(V) INTEGRATED CIRCUITS

The terminal provides up to 16 different narrow-band voice-frequency tone channels, each passing a different band of frequencies. Associated with each channel are two oscillators and a gate circuit. One oscillator constantly generates the mark frequency; the other constantly generates the space frequency. The gate circuit is keyed by a telegraph loop causing one frequency or the other to pass (frequency-shift keying). The two frequencies are symmetrically disposed with respect to the center of the channel pass-band. The output from any set of different channels can be combined on a single line for transmission over a single 3-kilocycle communication link.

Two 3-kilocycle bandwidth voice-frequency signals can be accommodated by the Telegraph Terminal, for transmission over a single 6-kilo cycle communication link. The two 3-kilocycle signals may contain 16 telegraph tone channels in each 3-kilocycle band or 16 telegraph tone channels in one 3-kilocycle signal and speech in the other 3-kilocycle signal.

Diversity-combination switching is provided in the telegraph terminal at both the transmitting and receiving stations; thus, one telegraph signal can be used to key two different tone channels (Keyers) at the transmitting station. In this case, the corresponding tone channels (Converters) at the receiving station both develop keying signals. However, the best signal of the diversity pair operates the receiving telegraph loop, thereby preserving the telegraph signals when fading occurs in one of the two channels in the frequency-diversity pair.

Diversity switching at the receiving station also permits space-diversity or r-f diversity operation, in which tone signals obtained from two different radio receivers are used to operate two identical sets of tone channels. For this type of operation, each pair of identical tone channels (Converters) provides a single keying signal. Frequency-diversity operation can be combined with either space-diversity or r-f diversity operation. In this case, one set of four tone channels produces a single keying signal.

In place of 16-narrow-band channels, the Telegraph Terminal can provide eight narrow-band and four wide-band channels. The wide-band channels use the band portion of the upper eight narrow-band channels plus the band extending from 3025 to 3315 cps. However, extension of the wide-band channels above 3265 cps prevents use of the multiplexing function.

Special test facilities required to align the Telegraph Terminal are incorporated in the portable Test Set.

Integrated circuits of two types, a differential amplifier and a flip-flop, are used throughout Telegraph Terminal AN/UCC-1C(V). Although each integrated circuit is housed in a transistor enclosure, it performs a much more complex function than a single transistor. External electronic components such as resistors and capacitors are used with integrated circuits, as they are with transistors, when the application of the device requires their use.

Standard schematic symbols for integrated circuits have not been adopted as yet. The symbols used to represent the differential

amplifier and the flip-flop have been approved for use by the Bureau of Ships. These symbols were developed by placing the standard logic symbol for the circuit within a standard envelope or enclosure. All signal paths have been drawn through the envelope to the logic symbol. Other connections to the circuit such as voltage supplies, common connections, gain control, and operating bias are drawn only to the envelope. To understand fully the schematic diagrams employing these symbols, it will be necessary to study the schematic diagrams and explanations of the integrated circuits.

CONSTRUCTION OF INTEGRATED CIRCUITS. - The integrated circuit consists of a number of transistors or diodes and other circuit elements formed on a single substrate or chip of N-type, doped silicon crystal. The circuit elements are formed on this substrate by semiconductor construction methods including masking, oxide photolithographic etching, diffusion, evaporation, epitaxial growth, and deposition. Then, lead wires are connected to the integrated circuit by thermal compression bonding and it is sealed in the enclosure or envelope.

DIFFERENTIAL AMPLIFIER. - Figure 3 shows the schematic symbol and the internal schematic diagram of the differential amplifier. Signal inputs are applied to leads 2 and 3 of the integrated circuit, the bases of Q1 and Q2 which are shown in the internal schematic diagram. These input signals are amplified by Q1 and Q2 and applied to the bases of output emitter followers Q3 and Q4 respectively. Output signals from the emitter followers are available at leads 10 and 7 of the integrated circuit. In addition, the output signals at the collectors of Q1 and Q2 are available at leads 1 and 6 of the integrated circuit. The constant current source for Q1 and Q2 is Q5 which determines the gain of the differential amplifier by determining the emitter currents of Q1 and Q2. The gain of the amplifier may be controlled by applying a signal to the base of Q5 through R6 at lead 8 of the integrated circuit. The emitters of Q1 and Q2 are brought out at lead 4 of the integrated circuit. This lead may be used to bypass the constant current source Q5 when the application requires. Leads 9 and 5 are the connections for B+ voltage and common respectively. Resistance values as noted on the schematic diagram are nominal and may vary quite widely from unit to unit. Care should be exercised if attempting to measure the internal components values to prevent erroneous readings due to internal connections and to prevent damage to the module by application of either excessive current or voltage or both.

FLIP-FLOP - The flip-flop is a direct-coupled integrated circuit using resistor-transistor logic. Figure 4 shows the schematic symbol for the flip-flop and the internal schematic diagram of this circuit. The set and reset input signals are gated by identical input gates. The set gate consists of Q1, Q2, and Q3. The reset gate consists of Q6, Q5, and Q4. Input inverters Q1 and Q6 receive and invert the set and reset signals respectively. Transistors Q3 and Q4 sense the state of the inputs, and Q2 and Q5 prevent reaction when the clock input is low. Transistors Q8 and Q9 perform the function of charge storage. When either transistor is forward-biased with its base at a high level and its collector at a low level, its collector-base junction charges. This condition occurs only when the output of the transistor's gate is high, which in turn, occurs only when all three inputs to the gate are low. The output flip-flop (Q11 and Q12) is cross-connected to the

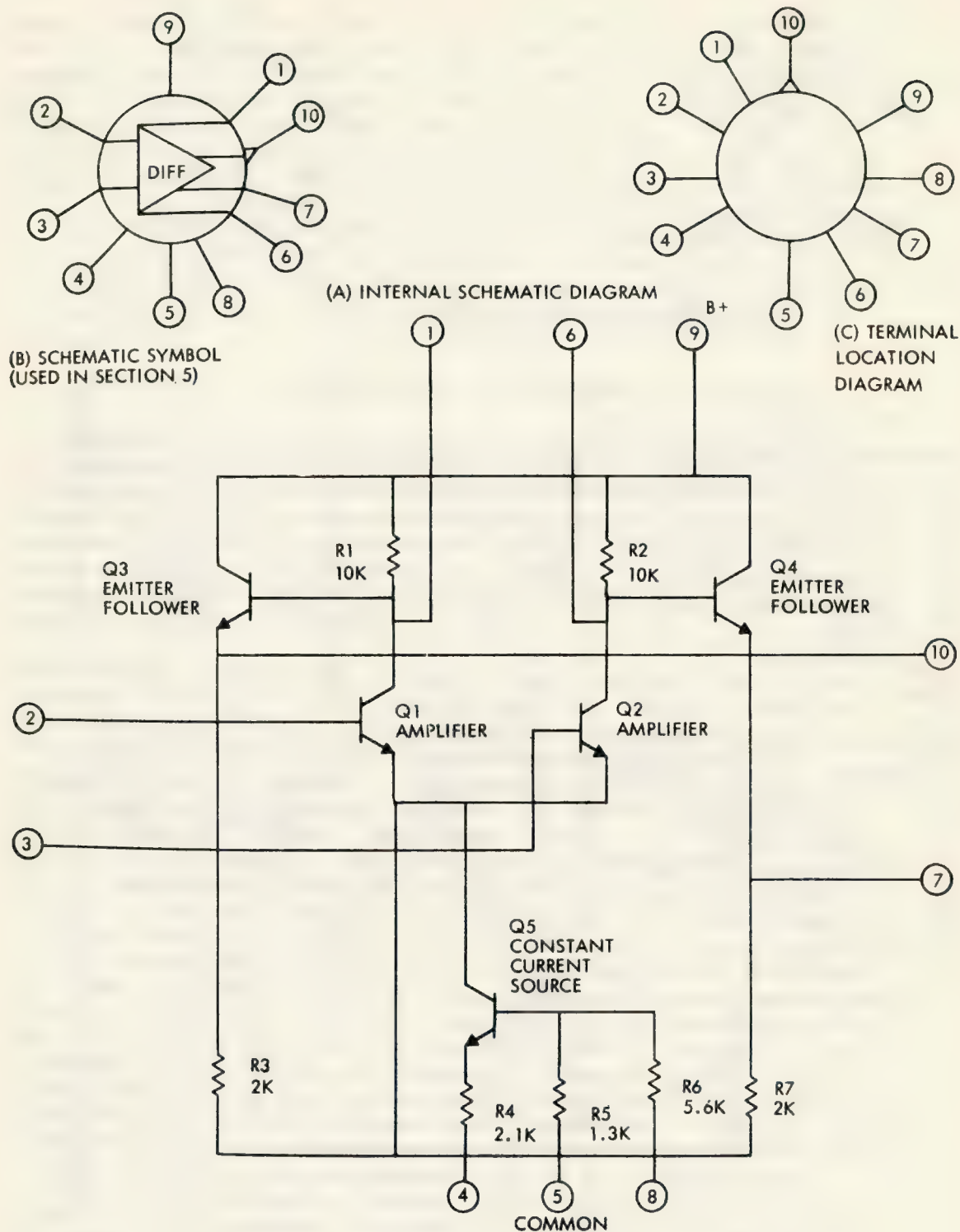
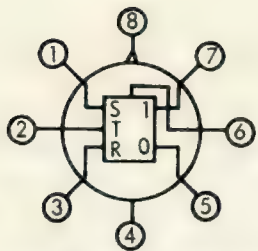
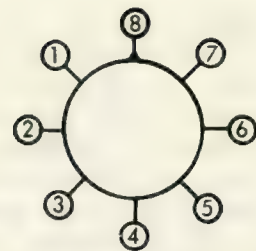


Figure 3 Differential Amplifier, Integrated Circuit Device
AN/UCC-1C(V)



(B) SCHEMATIC SYMBOL
(USED IN SECTION 5)



(C) TERMINAL LOCATION
DIAGRAM

(A) INTERNAL SCHEMATIC DIAGRAM
NOTE: RESISTANCE VALUES ARE NOMINAL

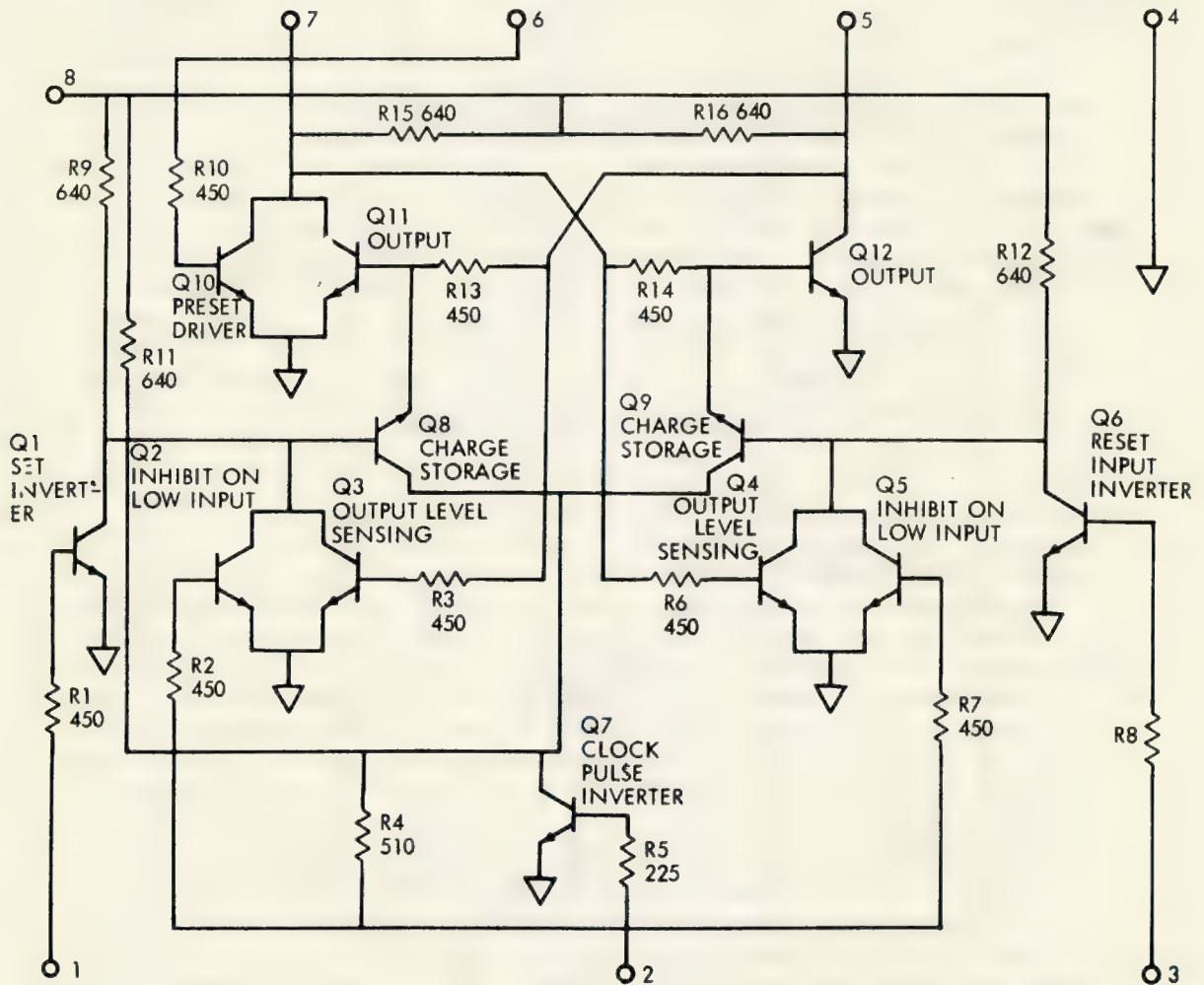


Figure 4 Flip-Flop, Integrated Circuit Device
AN/UCC-1C(V)

gates. Because only one side is low at a time, only one transistor (Q8 or Q9) can charge at a time. The clock input is high during the charging cycle; it is inverted by Q7 to present a low level to the gates. As the clock pulse falls, the collector of the charge-storage transistor goes high, releasing its charge. If the associated output flip-flop transistor (Q11 or Q12) is off, the charge drives it on. When either Q11 or Q12 is driven on, it drives the other transistor off. The preset driver Q10 is the means of assuring that the flip-flop is in the set condition when the application requires that the circuit be in a known condition. The preset signal at lead 6 of the integrated circuit is applied to the base of Q10, which functions just as Q11, turning Q12 off and turning Q11 on.

APPLICATION OF THE INTEGRATED DIFFERENTIAL AMPLIFIER.

In addition to the basic application as a differential amplifier, the integrated differential amplifier is used in a Schmitt trigger, a crystal-controlled oscillator, and a free-running multivibrator. The adaption of this integrated circuit to these applications was undertaken in the design of Telegraph Terminal AN/UCC-1C(V) to improve reliability and to reduce the number of spare parts required. External electronic components are connected into the circuit to adapt it to these applications.

SCHMITT TRIGGER.--The Schmitt trigger circuit uses only two of the transistor sections of the integrated circuit. Figure 5 shows the schematic diagram of this circuit and also a schematic diagram showing the internal elements of the integrated circuit device (internal schematic diagram). The elements of the integrated circuit which are not used are shown by the dashed lines of the internal schematic diagram. The Schmitt trigger is a wave-shaping circuit used to produce a square wave to assure positive triggering. Refer to the internal schematic diagram (figure 5). In the space condition, transistor section Q1 is cut off and Q2 is conducting. The output from the collector of Q1, IC1 lead 1, is a mark. When the teletypewriter loop current at a positive voltage is furnished to the base of Q1, this amplifier stage goes quickly into saturation. The output at the collector is is furnished at high impedance to the base of Q2 causing Q2 to cut off rapidly. When Q2 cuts off, almost the entire +12 volts at the collector is furnished to IC1 lead 6. The rapid transitions from saturation to cutoff and from cutoff to saturation produce a well-defined square wave with an amplitude of approximately +12 volts for the mark condition, at lead 6. The RIAS ADJ, R5 adjusts the triggering point on the teletypewriter d-c loop current waveform by adjusting the operating bias of the circuit. Although emitter followers Q3 and Q4 are not used in the application as a Schmitt trigger, they change state in synchronism with Q1 and Q2.

CRYSTAL-CONTROLLED OSCILLATOR.--The crystal-controlled oscillator uses three of the five transistor sections of the integrated circuit. Figure 6 shows the schematic diagram and also the internal schematic diagram of this circuit.

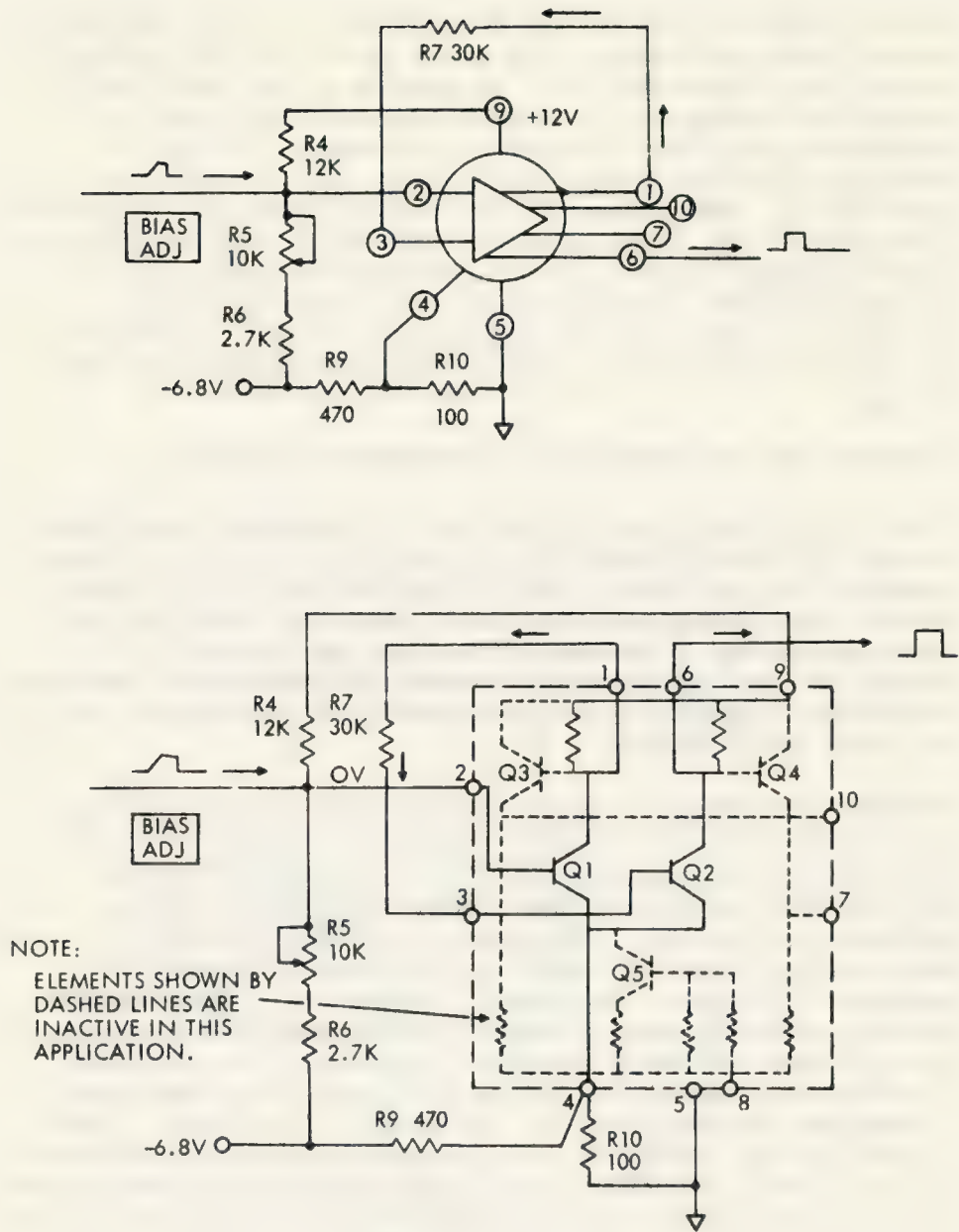


Figure 5 Schmitt Trigger Circuit, Schematic Diagram
AN/UCC-1C(V)

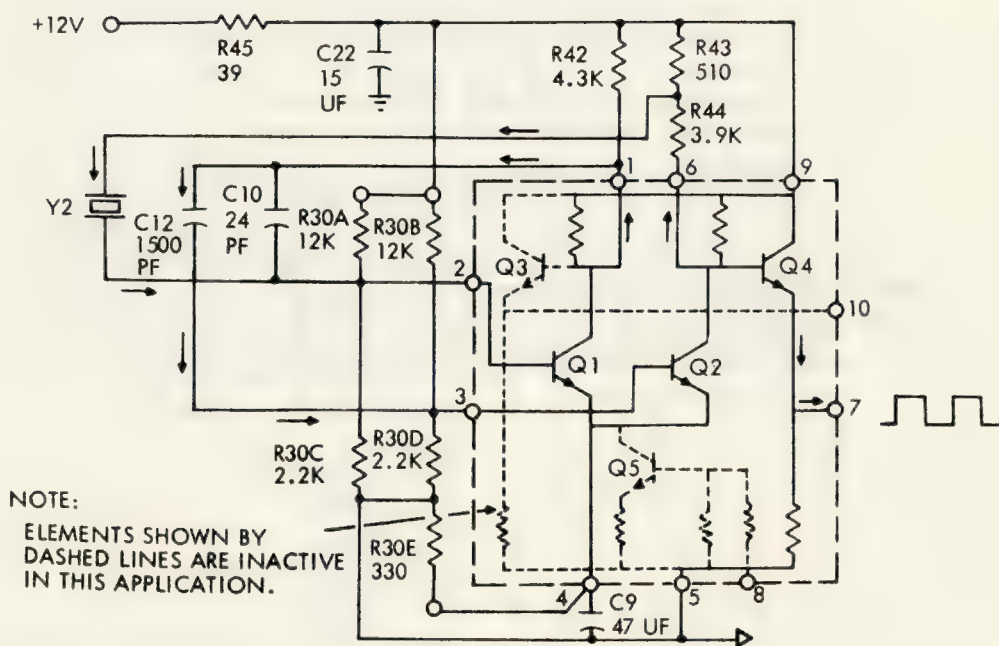
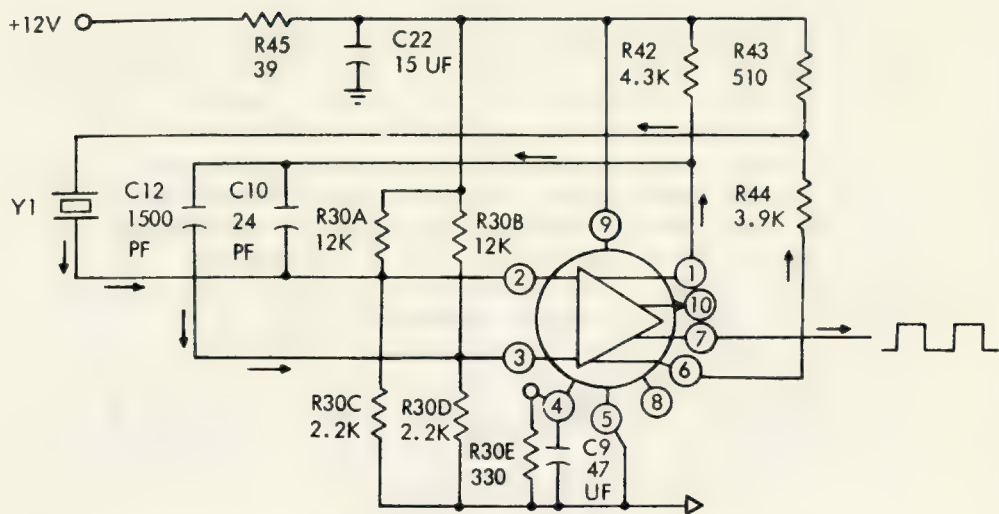


Figure 6. Crystal-Controlled Oscillator, Schematic Diagram
AN/UCC-1C(V)

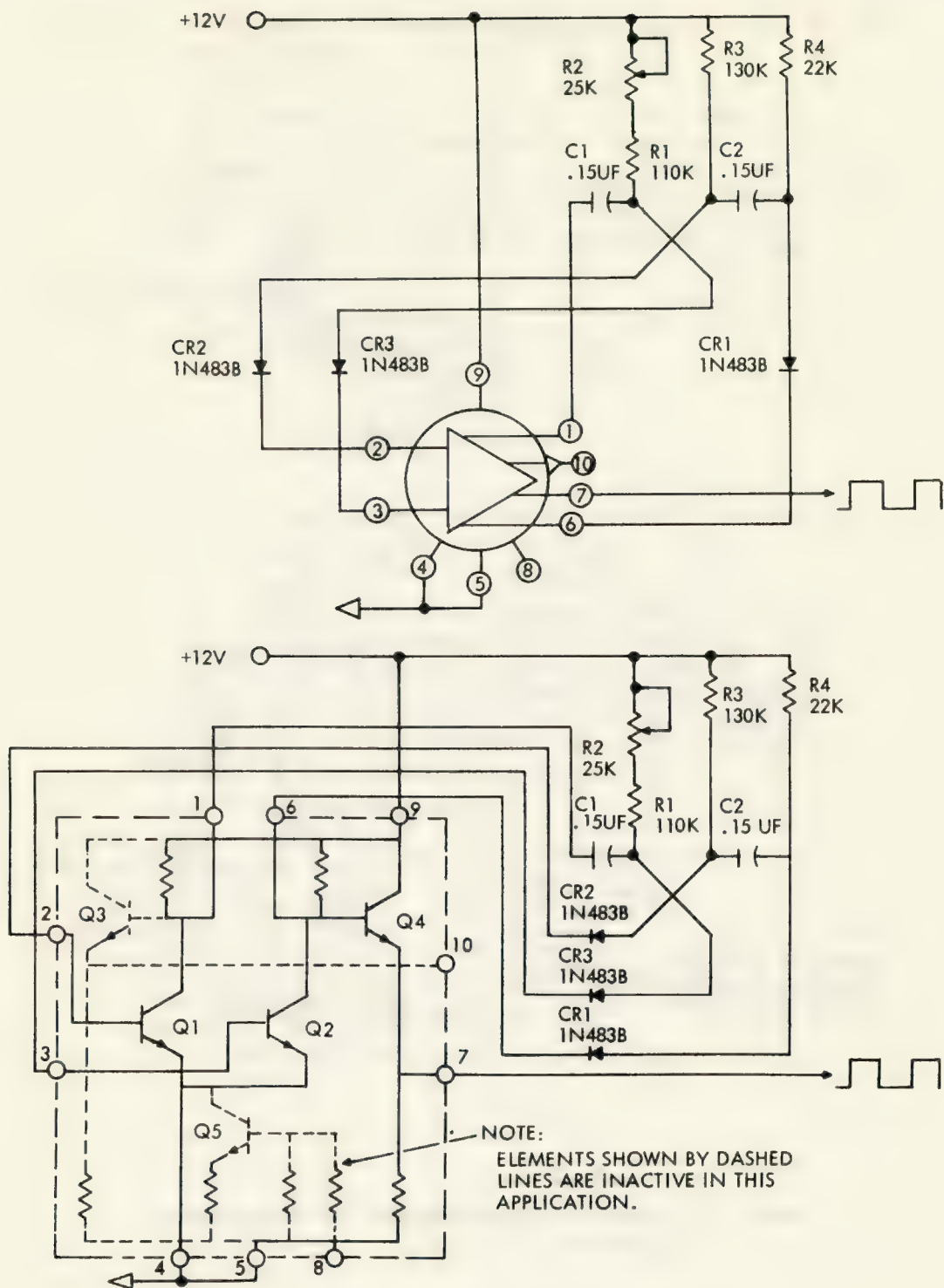


Figure 7 Free-Running Multivibrator, Schematic Diagram
AN/UCC-1C(V)

This oscillator consists of two amplifier stages in series with positive feedback from the output of the second stage to the input of the first stage. Refer to the internal schematic diagram, figure 6. Each of the amplifiers produces a phase shift of 180 degrees yielding the total phase shift of 360 degrees required in the feedback loop to sustain oscillation. When power is applied to the circuit, Q1 starts to conduct furnishing a driving signal to the base of Q2. The output at the collector of Q2 is fed back to the frequency control crystal Y2 causing it to start oscillating. The output from Y2 is in phase with the signal at the base of Q1 driving Q1 and Q2 further into conduction. As the output of Y2 reverses, it drives Q1 and, in turn, Q2 toward cutoff. The downward swing at the collector of Q2 is in phase with Y2 and causes Y2 to resonate producing the maximum output. The square wave produced at the collector of Q2 is fed out through an emitter follower Q4.

FREE-RUNNING MULTIVIBRATOR.--The free-running multivibrator uses three of the five transistor sections of the integrated circuits. Figure 7 shows the schematic diagram and also the internal schematic diagram of the circuit. The basic multivibrator consists of Q1, Q2 and r-c timing components. Transistor section Q4 is an output emitter follower. This circuit is essentially a collector-coupled multivibrator. The discharge path for C2 is toward +12 volts through R3. The discharge path for C1 is toward +12 volts through R1 and R2. The variable resistor R2 is used to balance the time constant of the two arms of the circuit. Diodes CR1, CR2, and CR3 protect the base-emitter junctions of the transistors from damage by the charge of approximately 12 volts on C1 and C2.

AN/UCC-1C(V) FREQUENCY SHIFT KEYER, KY-558(P)

STUDY ASSIGNMENT

NAVSHIPS 0967-046-9010, Technical Manual for Telegraph Terminal AN/UCC-1C(V) pages 4-6 through 4-14.

STUDY QUESTIONS

1. What types of DC inputs is the KY-558(P) designed to accept?
2. State the purpose of the bias adjust resistor, R5.
3. Explain the operation of the diode gate with a mark input to the keyer.
4. What is the purpose of CR-5 and CR-6?
5. What is the frequency of the mark oscillator in channel five?
6. State the purpose of the signal sense switch.

AN/UCC-1C(V) FREQUENCY SHIFT KEYER

INTRODUCTION

Each Frequency Shift Keyer provides one channel that accepts d-c telegraph signals from an external loop, and supplies the appropriate voice-frequency mark/space frequency-shift output signal.

The Keyer provides polar or neutral loop operation without any change in switch settings. Keyer switches may be set to:

- 1 Allow 60- or 20-ma loop operation,
- 2 Provide normal or reversed voice-frequency signal sense,
- 3 Place the output Signal on an individual output line or on the composite output line,
- 4 Enable interconnection of two Keyers, to form a frequency-diversity pair so that a signal d-c telegraph input produces outputs at two different voice frequencies,
- 5 Enable interconnection of four Keyers to form a frequency-diversity combination so that a single d-c telegraph input produces outputs at four voice frequencies.

The Keyer has its own power supply; all active Keyer components are contained on a plug-in printed circuit card that is interchangeable with cards of other Keyers.

REFERENCES

NAVSHIPS 0967-046-9010 Technical Manual for Telegraph Terminal AN/UCC-1C (V)

INFORMATION

KEYER CIRCUIT DESCRIPTION.-(See Keyer Frequency Shift Block Diagram)
The d-c telegraph loop is connected to the Schmitt trigger circuit IC1 through the 20-ma/60-ma switching circuit and the adjustable trigger-level bias control circuit. The adjustable bias sets the trigger level at one half the loop current value for neutral operation and at zero current for polar operation. The input level applied to the Schmitt trigger is the sum of the trigger-level bias and the voltage drop produced by loop current through resistors of the 20-ma/60-ma switching circuit. The change of input resistance for 20-ma or 60-ma loop operation assures that the voltage amplitude of the signals applied to the Schmitt trigger circuit is the same for both types of operation.

In neutral operation, the input transistor section of the Schmitt trigger IC1 is turned on (conducting) when loop current flows and is turned off (not conducting) in the absence of loop current. In polar operation, the input transistor section of IC1 is turned on during positive loop current and is turned off during negative loop current.

The output signal of the Schmitt trigger circuit and the output frequencies of the mark and space crystal-controlled oscillators (IC9 and IC10) are used to drive the diode gates. When the SIGNAL SENSE switch is in the NORMAL position, a loop current (mark input) causes the gate circuits to pass the output of the mark (higher frequency) oscillator. When the switch is in the REVERSE position, a loop current causes the gate circuits to pass the output of the space (lower frequency) oscillator.

The mark and space oscillators operate at frequencies which are 128 times the mark and space frequencies of the channel. They are controlled by crystals to maintain the frequency within a close tolerance. Both oscillators operate at all times but the output of each is passed through its gates only when the gate is enabled by the Schmitt trigger.

The oscillator frequency passed through the gate is divided by 128 in the divider circuit. The divider is a seven-stage digital count-down circuit consisting of IC2 through IC8. Each stage is a flip-flop integrated circuit device.

The output of the divider circuit (channel mark or space frequency) is applied through the output amplifier Q1 to the output bandpass filter.

Power for the Keyer circuit is supplied by regulated power supply circuits in the Keyer module.

KEYER DIVERSITY COMBINATIONS.- (See Block Diagram)

The cabinet is wired in such a way that the Keyers in specific cabinet stations can be connected in frequency-diversity pairs. These pairs of cabinet stations are: A1 and A2, A3, and A4, A5 and A6, and A7 and A8. The cabinet also is wired in such a way that the Keyers in specific cabinet stations can be connected to obtain four channel-diversity operation. These groups of four cabinet sections are: A1 through A4 and A5 through A8.

With the DIVERSITY switches of the Keyers in the ONE position, each Keyer is connected to a separate input telegraph loop. Turning the DIVERSITY switches of two Keyers in the stations which are wired to form a diversity pair, to the TWO position connects them to the same input telegraph loop. Both channels process the same input telegraph signals. Turning the DIVERSITY switches of the four Keyers in cabinet stations A1 through A4 or in A5 through A8 to FOUR connects the four Keyers to the same input telegraph loop. The DIVERSITY switches of all Keyers in a diversity combination must be in proper position.

The modules plugged into the two or four stations are selected to form a standard frequency-diversity combination.

The signals from the output bandpass filter are applied to the TONE OUTPUT switch. When the switch is set to PARALLEL, it applies the channel output through the Control-Attenuator to the composite tone output line. When the switch is set to INDIV, it applies the channel output directly to the individual tone contacts of the cabinet connector for individual tone output.

INITIAL ADJUSTMENT OF AN/UCC-1C(V) FREQUENCY SHIFT KEYER, KY-558(P)

INTRODUCTION

Initial adjustment of the keyer is a maintenance routine which is required upon installation of the terminal or upon installation of a new keyer in a terminal.

EQUIPMENT

TS-2232/UCC-1C(V) Telegraph Test Set

AN/USM-117 Oscilloscope or equivalent

REFERENCE

NAVSHIPS 0967-046-9010 Technical Manual for Telegraph Terminal AN/UCC-1C(V), pages 2-23 through 2-26, paragraph b.

JOB STEPS

Step 1. Turn to page 2-23 of the technical manual and find paragraph "b. Keyer."

Step 2. To perform this procedure assume the following system characteristics:

a. The cabinet contains two sending frequency diversity channels and two receiving frequency diversity channels.

b. Loop current is 60 ma.

c. Mark frequencies are higher than space frequencies.

Step 3. Perform all steps under (1) and stop before starting (2).

Step 4. Have instructor check work before proceeding. Initial_____

Step 5. Proceed with (2) steps (a) through (d).

Step 6. Have instructor check work before proceeding. Initial_____

Step 7. Complete steps (e) and (f).

Step 8. Have instructor check work before proceeding. Initial_____

Step 9. Under (3) complete steps (a) through (e)

Step 10. Have instructor check work. Initial_____

Step 11. Disconnect test equipment.

Step 12. Repeat the procedure under (1) and (2) assuming the following system characteristics:

- a. The cabinet contains four sending non-diversity channels and four receiving non-diversity channels.
- b. Loop current is 60 ma.
- c. Mark frequencies are lower than space frequencies.

SELF-TEST ITEMS

The following self-test items have been developed to help you determine how well you understand the maintenance routine described in this job sheet and how well you can determine the correct settings for various system characteristics. Place a circle around the letter preceeding the correct answer.

1. To set the keyer for loop current of 20 ma, you connect
 - a. black to green.
 - b. black to red.
 - c. green to red.
2. For a RF frequency diversity system, you set the keyer DIVERSITY switch to
 - a. ONE.
 - b. TWO.
 - c. FOUR.
3. For a system in which space frequencies are higher than mark frequencies, you set the keyer SIGNAL SENSE switch to
 - a. NORMAL.
 - b. REVERSE.
 - c. NEUTRAL.
4. To set the keyer for loop current of 60 ma, you connect
 - a. black to green.
 - b. black to red.
 - c. green to red.

5. For a frequency-space diversity system, you set the keyer DIVERSITY switch to
 - a. ONE.
 - b. TWO.
 - c. FOUR.
6. For a frequency-space diversity system, you set the keyer TONE OUTPUT switch to
 - a. INDIVIDUAL.
 - B. PARALLEL.
7. For a non-diversity system, you set the keyer TONE OUTPUT switch to
 - a. INDIVIDUAL.
 - b. PARALLEL.
 - c. May be either.
8. For either a space diversity or an RF diversity system you set the keyer TONE OUTPUT switch to
 - a. INDIVIDUAL.
 - b. PARALLEL.
9. For an RF diversity system, you set the keyer DIVERSITY switch to
 - a. ONE.
 - b. TWO.
 - c. FOUR.
10. The keyer settings for a space diversity system are
 - a. exactly the same as for non-diversity.
 - b. different than those for non-diversity.

OPERATOR'S CHECKS FOR AN/UCC-1C(V) KEYER, KY-588(P)

INTRODUCTION

The operator's checks form a simple maintenance routine which assures the operator that the equipment is operating correctly. They can be performed without interfering with system operation.

EQUIPMENT

TS-2232/UCC-1C(V) Telegraph Test Set

REFERENCE

NAVSHIPS 0967-046-9010 Technical Manual Telegraph Terminal AN/UCC-1C(V), page 3-7, paragraph (1).

JOB STEPS

Step 1. Turn to page 3-7 of the technical manual and find paragraph " (1) KEYER CHECKS. "

Step 2. Complete steps (a) and (b).

Step 3. Have instructor check work before proceeding Initial_____

Step 4. Complete step c.

Step 5. Have instructor check work. Initial_____

SELF-TEST ITEMS

The following self-test items have been prepared to help you determine how well you understand the maintenance routine described in this job sheet and related information. Place a circle around the letter preceding the correct answer.

1. If the FUNCTION SELECTOR switch of the test set is set to REV.OUT when the test connector is plugged into an operating keyer, the following will result:

- a. nothing will happen.
- b. a fuse will blow.
- c. the keyer will be damaged.
- d. the communications in the channel will be interrupted.

2. If the FUNCTION SELECTOR switch is set to TONE OUT when the test connector is plugged into an operating keyer, the following will result:
- a. nothing will happen.
 - b. a fuse will blow.
 - c. the keyer will be damaged.
 - d. the communication in the channel will be interrupted.
3. If the loop current is found to be out of tolerance in the loop current check, the probable cause is:
- a. R1 is open.
 - b. F1 is open.
 - c. the external loop supply needs to be adjusted.

ALIGNMENT OF AN/UCC-1C(V) KEYER, KY558(P)

INTRODUCTION

The keyer alignment should be performed after repair or replacement of the keyer front chassis assembly circuit card.

EQUIPMENT

TS-2232/UUV-1C(V) Telegraph Test Set

REFERENCE

NAVSHIPS 0967-046-9010 Technical Manual for Telegraph Terminal AN/UCC-1C(V), page 5-1, paragraph 5-5.

JOB STEPS

- Step 1. Complete the procedure described under a. of paragraph 5-5 in the technical manual.
- Step 2. Have instructor check work before proceeding. Initial_____
- Step 3. Complete steps (1) through (3) described under b.
- Step 4. Have instructor check work before proceeding. Initial_____
- Step 5. Complete steps (4) through (6).
- Step 6. Have instructor check work before proceeding. Initial_____
- Step 7. Complete steps (7) and (8).
- Step 8. Have instructor check work before proceeding. Initial_____
- Step 9. Transmit a dot cycle to the keyer from the system loop current source and make final adjustment of the BIAS control if necessary.
- Step 10. Have instructor check work. Initial_____

SELF-TEST ITEMS

The following self-test items have been developed to help you determine how well you understand the maintenance routine described in this job sheet and related information. Place a circle around the letter before the correct answer.

1. When you adjust the TONE control R14, you are adjusting the level of the output by
 - a. adjusting the gain of the output amplifier.
 - b. adjusting the level of the input to the output amplifier.

c. adjusting the output of the amplifier prior to the transmit bandpass filter.

2. When you adjust keyer bias you use one half the specified loop current value. The most logical reason for this is

a. to assure positive switching at full loop current.

b. to compensate for possible drops in line voltage during operation.

c. to reduce distortion by causing the switching to occur in the middle of the mark-space transition.

3. With zero loop current and the signal sense switch at normal, you could obtain a keyer mark output with

a. the BIAS pot fully clockwise.

b. the BIAS pot fully counterclockwise.

4. The normal voltage level at IC1 pin 2 with the keyer in a steady mark condition is

a. -0.3 volts.

b. 0 volts.

c. + 0.1 volt.

AN/UCC-1C(V) FREQUENCY SHIFT CONVERTER, CV-1920(P)

STUDY ASSIGNMENT

NAVSHIPS 0967-046-9010, Technical Manual for Telegraph Terminal AN/UCC-1C(V), Pages 4-13 through 4-21

STUDY QUESTIONS

1. What two factors determine diversity combinations of converters? Why?
2. In diversity operation-
 - a. The outputs of the discriminators are placed in series with each other and are applied between which circuits?
 - b. In two diversity these circuits can be located in which cabinet stations?
3. What are the two types of input lines in the converter?
4. In diversity operation, where is the common AGC line connected?
5. Explain how the strongest signal controls the loop in a diversity hook up.
6. What is the purpose of:
 - a. FL1
 - b. ALR2
 - c. A1IC4
 - d. FL2

AN/UCC-1C(V) Frequency Shift Converter

INTRODUCTION

Each converter provides one channel that accepts a particular frequency-shift voice-frequency signal, and provides an electronic keying signal for operation of a DC telegraph loop. Switch settings allow connection of either 2 or 4 converters to form diversity combinations. The converter has its own power supply.

REFERENCE

NAVSHIPS 0967-046-9010 Technical Manual for Telegraph Terminal AN/UCC-1C (V)

INFORMATION

CONVERTER CIRCUIT DESCRIPTION.--(See Servicing Block Diagram)

Either a composite tone signal or an individual tone signal is fed to the input filter FL1, a bandpass filter which blocks all channel frequencies except those of the Converter's channel. The filter also contains the adjustable delay network that provides the means for equalizing delays for diversity operation.

The output of the filter is applied to the attenuator and bias network A1R2. This network provides the AGC attenuation and also biases the input gain-controlled amplifier A1IC1.

The output of A1IC1 is r-c coupled to the input of the second gain controlled amplifier A1IC2. The gain of both amplifiers is varied by changing the voltage applied to the constant-current generator in the integrated circuit device.

The output of the second gain-controlled amplifier is applied to the input of amplifier A1IC3 which has fixed gain. The output of A1IC3 is r-c coupled to the limiter stage A1IC4 which clips the signal removing any amplitude-modulated components from the waveform applied to the discriminator.

Transformer A1T1 couples the output of A1IC3 to the gain and level control circuits. The output taken at terminal 4 of A1T1 is rectified and applied to the AGC detector transistor A1Q4. This voltage establishes the conduction level of A1Q4.

The amplified output of A1Q4 is applied to the AGC control amplifier A1Q5 which provides the power gain necessary to drive the gain-controlled stages A1IC1 and A1IC2.

The output taken from terminals 5 and 6 of A1T1 is rectified and filtered by rectifier-filter consisting of diodes A1CR17 through A1CR20 and A1C19, and applied to a compound emitter follower A1Q2. The output of A1Q2 is a d-c voltage proportional to the AGC output level. It is used to limit the amplitude of the drive voltage to the discriminator FL2. In diversity operation, when the gain of the receiver is reduced, the discriminator drive waveform is reduced assuring that a linear combination of detected signals results in the mark-space detection.

The amplitude-limited output of A11C4 is applied to the discriminator FL2 which generates a d-c signal of one polarity when the tone signal is at the mark frequency and of the opposite polarity when the tone signal is at the space frequency. The output of the discriminator is added to the bias level supplied by the bias level network and fed through emitter follower A1Q3 to the output level detector A1Q1, a regenerative amplifier. The polarity of the discriminator output connection is determined by the SIGNAL SENSE switch S2.

When the SIGNAL SENSE switch S2 is set to NORMAL, the polarity of the connection is such that the discriminator supplies a negative level when the tone signal is at the mark frequency. With S2 set to REVERSE, the discriminator supplies a positive level to the emitter follower for a mark frequency tone and supplies a negative level to the emitter follower for a space frequency tone.

The regenerative amplifier A1Q1 provides a stable reference for the detection threshold. A negative input cuts off A1Q1B holding A1Q6 in conduction so that loop current flows. When a positive input is applied to A1Q1B, A1Q6 is held off and presents a high impedance so that no loop current can flow. The regenerative action of A1Q1B and A1Q1A assures that the output switch A1Q6 is always in either non-conducting or full-conducting condition.

CONVERTER DIVERSITY COMBINATIONS.--(See block diagram)

The two factors which determine diversity connections are switch settings on the individual Converters and Cabinet positions(stations) occupied by the Converters. Because Cabinet wiring for stations A1 through A4 is identical to that for stations A5 through A8, The Block Diagram illustrates only one four-station group.

Each Channel, regardless of the station into which it is plugged, can be connected to an associated individual input transformer within the input filter FL1, or to either of two composite input transformers (designated as RCVR A and RCVR B) within the input filter. The two composite input lines are used in the frequency-diversity/space-diversity system. In this system, two converter modules are assigned to each channel. One group of four converters (for the eight channels) processes signals from radio receiver A, which appear on the RCVR A input line; the other group of four Converters processes signals from radio receiver B, which are furnished on the RCVR B input line. With the TONE INPUT switches set as shown, the Converters in stations A1 and A3 are connected to receiver A and the Converter in stations A2 and A4 are connected to receiver B: The Converters in stations A1 and A3 function as a frequency-diversity pair, and those in stations A2 and A4 function as a frequency-diversity, those in A1 and A2 function as a space-diversity pair, and those in A3 and A4 function as a space-diversity pair. For example, the Converters in the first two stations might be 425-cps channels; those in A3 and A4 would be 1785-cps channels, thereby forming a narrow-band, frequency-diversity/space-diversity combination. In this combination, outputs of the four channel discriminators are added in series and applied between the bias network and the emitter follower input to the regenerative amplifier of the Converter in station A1. This can be verified by tracing the path

through the DIVERSITY switches, which are shown in the FOUR position. In order to combine the outputs of all four channels, the circuit grounds of the four channels must be tied together. This function is performed through one bank of the DIVERSITY switch and cabinet wiring.

To use the Converters in stations A1 through A4 as two separate frequency-diversity pairs, the DIVERSITY switch on each Converter must be set to two and the Converters must be rearranged. For example, the Converters used in stations A1 through A4, respectively, might be 425-cps, 1785-cps, 595-cps, and 2125-cps channels, the first two and the last two functioning as narrow-band frequency-diversity pairs.

With the DIVERSITY switches of the four Converters set to two:

1. Discriminator outputs of the modules in stations A1 and A2 are placed in series between the bias network and the input to the regenerative amplifier of the Converter in station A1.
2. Discriminator outputs of the modules in stations A3 and A4 are placed in series between the bias network and the input to the regenerative amplifier of the Converter in station A3.
3. The grounds of the Converters in stations A1 and A2 are tied together as are the grounds of the Converters in stations A3 and A4.

Since no space-diversity pairs are involved, all four of the TONE INPUT switches are set to the same position so that all four Converters are connected to the same composite tone line.

The composite input lines are connected to the composite-tone lines in the cabinet through the MODE switches on the Control-Attenuator, and the composite-tone lines are connected to the INTERCONNECT A and INTERCONNECT B connectors. The composite-tone lines are connected to the corresponding lines in other Cabinets when more than one Cabinet is used; in this case, the MODE switch is set to MASTER in one of the Cabinets and to SLAVE in each of the other Cabinets. The tone inputs are then received through the input transformers in the Cabinet which has the MODE switch set to MASTER. For example, one system, which employs four Cabinets containing Converters, The input lines of the top Cabinet and of the third Cabinet from the top are used.

Each Converter can be set to operate individually as a receiving channel by turning the DIVERSITY switch on the module to ONE. Each Converter can be connected to an individual input line by setting the TONE INPUT switch on the module to INDIV.

The Block Diagram illustrates the intermediate AGC circuit connections for diversity operation. Notice that these connections are made through another bank of the DIVERSITY switch.

When a group of Converters is used in a diversity combination the inputs to the AGC control amplifiers of all modules in the group are connected together. This common connection is at the collector of the AGC detector 1A2A1Q4 of each module. The converter receiving the strongest input signal produces the most negative output from the AGC detector. This signal overrides those of the other Converters and drives all AGC control amplifiers in the group.

The AGC control amplifiers of all Converters in the group are driven by the AGC signal of the Converter receiving the strongest input signal. This causes the discriminator drive signal of all Converters except the one with the strongest input signal to be attenuated with respect to the discriminator drive signal of the Converter receiving the strongest input signal. Thus, only the strongest input signal produces sufficient discriminator output to drive the regenerative amplifier (output level detector) A1Q1 and the output switch A1Q6.

INITIAL ADJUSTMENT OF AN/UCC-1C(V) CONVERTER, CV-1920(F)

INTRODUCTION

The converter switches must be set when the terminal is installed or when a converter rear chassis assembly is replaced.

EQUIPMENT

TS-2232/UCC-1C(V) Telegraph Test Set

REFERENCE

NAVSHIPS 0967-046-9010, Technical Manual for Telegraph Terminal AN/UCC-1C(V), page 2-26, paragraph d.

JOB STEPS

Step 1. Turn to page 2-26 of the technical manual and refer to "d. Converter."

Step 2. For the purpose of completing this job sheet, assume that the converter is to be used in a system with the following characteristics:

- a. frequency RF diversity
- b. mark frequencies are higher than space frequencies
- c. 60 ma. loop current.

Step 3. Complete steps (a) through (c).

Step 4. Have instructor check work before proceeding.

Initial_____

Step 5. Complete step (d).

Step 6. Have instructor check work.

Initial_____

SELF TEST ITEMS

The following self-test items have been developed to help you determine how well you understand the maintenance routine described in the job sheet and related information. Place a circle around the letter before each correct answer.

1. If the converter were being used in a frequency-space diversity system instead of a frequency-RF diversity system, the settings of the TONE INPUT switches would be

- a. the same.
- b. different.
- c. opposite.

2. Although the converters are being used in a diversity system, the DIVERSITY switch is set to ONE in Step(c). Why?

- a. this is a preliminary step to permit adjusting the LOOP current control on each converter.
- b. the current of each DC loop must be adjusted individually.

DISCRIMINATOR BALANCE AND BIAS ADJUSTMENTS
OF AN/UCC-1C(V) CONVERTER, CV-1920(P)

INTRODUCTION

Discriminator balance adjustment is a maintenance routine which should be performed as a part of initial calibration and adjustment. It should be checked whenever the ambient temperature of the equipment changes significantly. The converter bias should be adjusted whenever the balance adjustment has been disturbed.

EQUIPMENT

AN/USM-117 series oscilloscope, or equivalent

REFERENCE

NAVSHIPS 0967-046-9010 Technical Manual for Telegraph Terminal AN/UCC-1(V), page 2-27, paragraphs (2) and (3).

JOB STEPS

Step 1. Turn to paragraph (2) on page 2-27 of the technical manual.

Step 2. Complete steps (a) through (c).

Step 3. Have instructor check work before proceeding. Initial_____

Step 4. Complete steps (d) through (f).

Step 5. Have instructor check work before proceeding. Initial_____

Step 6. Complete step (g).

Step 7. Have instructor check work before proceeding. Initial_____

Step 8. Complete steps (a) through (e) of paragraph (3).

Step 9. Have instructor check work before proceeding. Initial_____

SELF TEST ITEMS

The following self-test items have been developed to help you determine how well you understand the maintenance routine described in the job sheet. Place a circle around the letter before each correct answer.

1. The converter bias must be adjusted after adjusting discriminator balance because

- a. the output of the discriminator more nearly resembles a sine wave than a square wave.
- b. the bias adjustment and the discriminator balance adjustment both are intended to adjust the marks and spaces of a dot cycle to equal durations. If the mark-to-space proportion is changed at the discriminator which occurs earlier in the signal path, then the bias must be adjusted to correct the mark-to-space proportion at the DC loop output.
- c. the bias voltage is affected by the discriminator balance adjustment.

2. Some of the following statements are true; others are false. Place a circle around true or false to indicate the correct answer.

- a. Adjusting the discriminator balance may be thought of as adjusting the zero reference point with respect to an AC waveform which resembles a sine wave.

True

False

- b. Adjusting converter bias may be thought of as adjusting the absolute level of the zero reference point to obtain marks and spaces of equal duration.

True

False

- c. When using a dot cycle for calibration, the BIAS control can be adjusted to obtain marks and spaces of equal duration even though the DISC BAL control is set incorrectly.

True

False

- d. The discriminator balance and the bias must be adjusted whenever the SIGNAL SENSE is changed.

True

False

- e. Bias can be adjusted with the DIVERSITY switch set to TWO or FOUR.

True

False

OPERATOR'S CHECKS FOR AN/UCC-1C(V) CONVERTER, CV-1920(P)

INTRODUCTION

The operator's checks form a simple maintenance routine which assures the operator that the equipment is operating correctly. They can be performed without interfering with system operation.

EQUIPMENT

TS-2232/UCC-1C(V) Telegraph Test Set

REFERENCES

NAVSHIPS 0967-046-9010 Technical Manual for Telegraph Terminal AN/UCC-1(V) page 3-7, paragraph 2.

JOB STEPS

Step 1. Turn to page 3-7 of the Technical Manual and find paragraph (2) "CONVERTER CHECKS"

Step 2. Complete steps (a) and (b).

Step 3. Have instructor check work before proceeding. Initial_____

Step 4. Complete steps (c) and (d).

Step 5. Have instructor check work. Initial_____

SELF TEST ITEMS

The following self-test items have been developed to help you determine how well you understand the maintenance routine described in this job sheet and related information. Place a circle around the letter before each correct answer.

1. With the converters operating in four-channel diversity combinations, loop current will be measured for

- a. the converters in cabinet stations A1 and A5.
- b. all converters
- c. the converters in cabinet stations A1, A3, A5, and A7.

2. In a diversity combination

- a. the input tone can be heard for only the converter with the strongest input level.
- b. the input tone for each converter can be heard.

DELAY EQUALIZATION ADJUSTMENT OF AN/UCC-1C(V) CONVERTER, CV-1920(P)

INTRODUCTION

Converter delay equalization is a maintenance routine which must be performed in preparation for diversity operation. It is unnecessary for non-diversity operation.

EQUIPMENT AND MATERIAL

TS-2232/UCC-1C(V) Telegraph Test Set

Two test leads with 0.080-inch diameter probes.

REFERENCE

NAVSHIPS 0967-046-9010 Technical Manual for Telegraph Terminal AN/UCC-1(V), page 2-27, paragraph (4) (a).

JOB STEPS

- Step 1. Make sure that the DIVERSITY switches on all converters in the diversity combination are set to the correct position (either TWO or FOUR).
- Step 2. Turn to paragraph (4) (a) on page 2-27 of the Technical Manual.
- Step 3. Complete steps 1 through 9.
- Step 4. Have instructor check work before proceeding. Initial_____
- Step 5. Complete steps 10 and 11.
- Step 6. Have instructor check work before proceeding. Initial_____
- Step 7. Complete steps 12 and 13.
- Step 8. Have instructor check work before proceeding. Initial_____
- Step 9. Complete steps 14 through 16.
- Step 10. Have instructor check work before proceeding Initial_____
- Step 11. Complete steps 17 and 18.
- Step 12. Have instructor check work before proceeding Initial_____
- Step 13. Perform steps 19 and 16 through 20 for the next converter requiring delay adjustment.

Step 14. Have instructor check work before proceeding. Initial_____

Step 15. Perform steps 19 and 16 through 20 for the final converter in the diversity combination.

Step 16. Have instructor check work before proceeding. Initial_____

Step 17. Disconnect the Test Set and replace the DC LOOPS connector in J8.

SELF TEST ITEMS

The following self-test items have been developed to help you determine how well you understand the maintenance routine described in the job sheet. Place a circle around the letter before each correct answer.

1. Delay equalization is necessary to
 - a. synchronize the converters in the diversity combination.
 - b. correct for timing distortion caused by differential delay in the channel.
 - c. correct for amplitude distortion in the channel.
2. Delay may vary from one converter to the next because of
 - a. variation in the characteristics of the input bandpass filters.
 - b. difference in delay between two radio receivers.
 - c. differential delay between two voice frequencies in the same band.
 - d. antenna spacing.
3. The DELAY control
 - a. is a 10,000 ohm variable resistor.
 - b. varies the resistance between terminals 4 and 5 of the discriminator.
 - c. varies the resistance between terminals 4 and 5 of the input filter.
4. The dot cycles used for delay equalization must be transmitted from the opposite end of the communications link because
 - a. there is only one test set per terminal
 - b. the delay equalization must compensate for all delay effects in the diversity channel.
 - c. the differential delay in the channel may vary with time.

DIVERSITY BALANCE ADJUSTMENT OF AN/UCC-1C(V) CONVERTER, CV-1920(P)

INTRODUCTION

Converter diversity balance is a maintenance routine which must be performed in preparation for diversity operation. It is not necessary for non-diversity operation.

EQUIPMENT

AN/USM-117 Oscilloscope or equivalent

REFERENCE

NAVSHIPS 0967-046-9010 Technical Manual for Telegraph Terminal AN/UCC-1-C(V), page 2-29, paragraph (4) (b).

JOB STEPS

Step 1. Turn to paragraph (4) (b) on page 2-29 of the Technical Manual.

Step 2. Complete steps 1 through 4.

Step 3. Have instructor check work before proceeding. Initial_____

Step 4. Complete step 5, a through c.

Step 5. Have instructor check work before proceeding. Initial_____

Step 6. Complete step 6, a and b.

Step 7. Have instructor check work before proceeding. Initial_____

Step 8. Complete step 6, c through g.

Step 9. Have instructor check work. Initial_____

SELF-TEST ITEMS

The following self-test items have been developed to help you determine how well you understand the maintenance routine described in this job sheet and related information. Place a circle around the letter before each correct answer.

1. Diversity balance is necessary to

- a. correct for amplitude distortion in the channel
- b. assure that the converter receiving the best signal is the one producing the output for the diversity combination.
- c. assure that the best converter in the diversity combination is placed in cabinet station A1, A3, A5, or A7.

2. For four-channel diversity operation, the diversity balance procedure must be performed for the converters in cabinet stations

- a. A1, A3, A5, and A7.
- b. A2, A4, A6, and A8.
- c. A1, A2, A3, and A4.
- d. A5, A6, A7, and A8.
- e. A1 and A5.

3. The DIV. BAL control adjusts the

- a. gain of one amplifier stage.
- b. gain of two amplifier stages.
- c. signal input to the AGC circuit.

CALIBRATION ADJUSTMENT OF AN/UCC-1C(V) CONVERTER, CV-1920(P)

INTRODUCTION

Converter calibration is a maintenance routine which must be performed after installation, repair or replacement of a converter. It is made up of the maintenance routines presented in Job Sheets 1-N4-4-1J through 1-N4-4-5J and is simpler for non-diversity than for diversity operation. The student should try to reach a thorough understanding of the need for various adjustments based on their effect on operation.

EQUIPMENT

TS-2232/UCC-1C(V) Telegraph Test Set

AN/USM-117 Oscilloscope or equivalent

Two test leads with 0.080 inch diameter probes

REFERENCES

Job Sheets 1-N4-4-1J through 1-N4-4-5J

NAVSHIPS 0967-046-9010 Technical Manual for Telegraph Terminal
AN/UCC-1C(V), pages 2-26 through 2-29 and figure 4-10 on page 4-19.

JOB STEPS

Step 1. Determine the adjustments required for non-diversity operation and write them in the spaces following.

Step 2. Have instructor check work before proceeding. Initial _____

Step 3. Determine the adjustments required for diversity operation and write them in the spaces below.

- Step 4. Have instructor check work before proceeding Initial_____
- Step 5. For the purpose of completing the job sheet, assume the converters are to be used in a system with the following characteristics:
- a. Two channel frequency diversity
 - b. Mark frequencies are higher than space frequencies
 - c. 60 ma loop current
- Step 6. Complete the initial adjustments for both converters as outlined in Job Sheet 1-N4-4-1J.
- Step 7. Have instructor check work before proceeding. Initial_____
- Step 8. Adjust the discriminator balance for one converter as outlined in Job Sheet 1-N4-4-2J.
- Step 9. Have instructor check work before proceeding. Initial_____
- Step 10. Adjust converter bias as outlined in Job Sheet 1-N4-4-2J.
- Step 11. Have instructor check work before proceeding. Initial_____
- Step 12. Complete converter delay equalization procedure as outlined in Job Sheet 1-N4-4-4J.
- Step 13. Have instructor check work before proceeding. Initial_____
- Step 14. Complete diversity balance procedure.
- Step 15. Have instructor check work. Initial_____

SELF TEST ITEMS

The following self-test items have been developed to help you determine how well you understand the maintenance routine described in the job sheet and related information. Place a circle around the letter before each correct answer.

1. Some of the procedures included in the calibration procedure must be performed for either diversity or non-diversity operation; they are:
- a. delay equalization.
 - b. discriminator balance.
 - c. bias adjustment.
 - d. diversity balance.
 - e. initial adjustment.

2. The discriminator balance procedure must be performed before the bias adjustment procedure; Why?

- a. to provide a stable frequency reference
- b. to assure that the mark-space transitions in the discriminator output occur at the right time.
- c. to provide marks and spaces of opposite but equal amplitude.

3. The bias adjustment procedure must be performed before the delay equalization procedure; Why?

- a. the signal used for delay equalization is the DC loop output of the converter.
- b. the bias adjustment procedure assures that the marks and spaces are of equal duration to ensure an accurate delay measurement.
- c. the bias adjustment procedure assures that the mark-space transitions are of equal amplitude.

4. The delay equalization procedure

- a. does not apply to non-diversity operation.
- b. assures that the signals out of the input filters of all converters are synchronized.
- c. can not accomplish its purpose unless the discriminator balance and bias adjustments have been made correctly before it is performed.

5. The diversity balance procedure

- a. assures that all converters in the diversity combination have equal gain.
- b. prevents an inferior signal from producing the output when a superior signal is present.
- c. adjusts the gain of the output stage.
- d. does none of these.

AN/UCC-1C(V) CABINET, ELECTRICAL EQUIPMENT AND CONTROL ATTENUATOR, C-6554

STUDY ASSIGNMENT

NAVSHIPS 0967-046-9010, Technical Manual for Telegraph Terminal AN/UCC-1C(V),
Page 4-21

STUDY QUESTIONS

1. Explain how the control attenuator keeps the signal to the transmitter constant.

2. Where do transformers 1A3T3 and 1A3T4 receive their input from?

3. What is the purpose of 1A3A1R8?

AN/UCC-1C(V) Control Attenuator

INTRODUCTION

The control attenuator has switches that permits selection of master or slave and connection of the composite voice-frequency lines to the connectors at the rear of the cabinet.

Each unit has a constant level amplifier that maintains the composite putput power at a constant level when up to 16 tones having a combined peak power within the range of -24 to ± 18 DBM, a control allows adjustment of the composite output power level.

REFERENCES

NAVSHIPS 0967-046-9010 Technical Manual for Telegraph Terminal
AN/UCC-1C (V)

INFORMATION

CONTROL-ATTENUATOR CIRCUIT DESCRIPTION.--(See Block Diagram)

When the Keyer TONE OUTPUT switches are in the PARALLEL position, the signals are combined and applied to the input transformer, T1, of the Control-Attenuator through the Mode switch. The output signal from T1 is applied to the input attenuation and bias network A1R2. The attenuation of this network is sufficient to provide the operating range for amplifiers A1IC1 and A1IC2. The network also biases the input gain-controlled amplifier A1IC1.

The output of A1IC1 is r-c coupled to the input of the fixed-gain amplifier A1IC2. The output of A1IC2 is transformer coupled to the output amplifier A1Q2. It is also transformer coupled, through terminals 4 and 6 of A1T1, rectified by A1CR1 and A1CR2, and applied to the base of the AGC detector transistor A1Q1B. Because the voltage required to cause this transistor to conduct is essentially constant, it serves as a reference to determine (detect) the level of the output signal from the fixed-gain amplifier A1IC2.

The amplified output of A1Q1B is applied to the base of emitter follower A1Q1A which functions as a power amplifier with sufficient gain to drive the gain-controlled amplifier A1IC1.

The output of A1T1 (terminal 4) is also applied to the base of the output power amplifier A1Q2. The LEVEL control A1R8 varies the output level by adjusting the level of the signal applied to the base of A1Q2. The signals from the power amplifier are coupled out of the Control-Attenuator by output transformer T2 Which is located in the rear chassis assembly.

Transformer T3 and T4 are the RCVR A and RCVR B isolation transformer. When signals are applied to their inputs, and when the MODE switch is in the MASTER POSITION, the input signals are applied to the RCVR A and RCVR B lines for application to the Converter inputs.

The 115 VAC/230 VAC switch on the front panel of the Control-Attenuator controls the application of power to the other modules in the Cabinet. When the switch is in the 115 VAC position, the input voltage is applied across the 115-volt input terminal of all power transformers; when the switch is in the 230 VAC position, the input

voltage is applied across the full primary windings of all power transformers. Pin RR must be connected to Pin SS on all cabinet stations in the enclosure when operating on 115V. Pin RR must be connected to Pin PP on all cabinet stations in the enclosure when operating on 230V.

INITIAL ADJUSTMENT OF AN/UCC-1C(V) CONTROL-ATTENUATOR, C-6554

INTRODUCTION

Initial adjustment of the control-attenuator is a maintenance routine which must be performed after installation, repair, or replacement of a control-attenuator.

EQUIPMENT

TS-2232/UCC-1C(V) Telegraph Test Set

REFERENCES

NAVSHIPS 0967-046-9010 Technical Manual for Telegraph Terminal AN/UCC-1C(V), page 2-20, paragraph 2-4a, and page 2-26c.

JOB STEPS

- Step 1. Turn to page 2-20, paragraph 2-4a, in the Technical Manual and complete step (1).
- Step 2. Determine the proper setting for the MODE switch and complete step (2).
- Step 3. Have instructor check work before proceeding. Initial_____
- Step 4. Complete step (3).
- Step 5. Place the control-attenuator and keyers in operation so that a composite tone output is obtained.
- Step 6. Set the FUNCTION SELECTOR switch of the Test Set to TONE IN and check each keyer for an output level of zero dbm.
- Step 7. Have instructor check work before proceeding. Initial_____
- Step 8. Turn to page 2-26, paragraph 2-4c, in the Technical Manual.
- Step 9. Complete steps (1) through (3).
- Step 10 Have instructor check work. Initial_____

SELF-TEST ITEMS

The following self-test items have been developed to help you determine how well you understand the maintenance routine described in this job sheet and related information. Place a circle around the letter before each correct answer.

1. The OUTPUT LEVEL control on the control-attenuator.

- a. must be adjusted for every installation.
- b. need not be adjusted for a converter installation.
- c. must be adjusted for every keyer installation.

2. The MODE switch

- a. must be set to MASTER if a connection is being made to the PARALLEL TONES XMIT jack.
- b. must be set to MASTER if a connection or connections are being made to the PARALLEL TONES RCVR A or RCVR B jacks.
- c. need not be set for a converter installation.
- d. must be set to SLAVE if no connection is made to the PARALLEL TONES jacks.

OPERATOR' CHECKS FOR AN/UCC-1C(V) CONTROL-ATTENUATOR, C6554

INTRODUCTION

The operator's checks form a simple maintenance routine which assures the operator that the equipment is operating correctly. The can be performed without interfering with system operation.

EQUIPMENT

TS-2232/UCC-1C(V) Telegraph Test Set

REFERENCE

NAVSHIPS 0967-046-9010 Technical Manual for Telegraph Terminal AN/UCC-1C(V), page 3-8, paragraph (3).

JOB STEPS

Step 1. Turn to paragraph " (3) CONTROL-ATTENUATOR CHECKS" on page 3-8 of the technical manual.

Step 2. Place the control-attenuator and a keyer in operation.

Step 3. Complete steps (a) and (b).

Step 4. Have instructor check meter indication. Initial_____

Step 5. Disconnect test set from control-attenuator.

SELF-TEST ITEMS

The following self-test items have been developed to help you determine how well you understand the maintenance routine described in this job sheet and related information. Place a circle around the letter before each correct answer.

1. The procedure described in this job sheet may be used
 - a. with all systems.
 - b. with converter systems.
 - c. with keyer systems.

2. The procedure described in this job sheet checks for
 - a. the presence of composite tone output.
 - b. the correct composite tone output level.
 - c. correct operation of T3 and T4 in the control-attenuator.
3. If no tone is present, and you have no spare module, you should
 - a. check control-attenuator +12Volts.
 - b. check keyer TONE OUT.
 - c. check DC loop supply.
4. If the tone level is incorrect you should
 - a. adjust control-attenuator gain.
 - b. check keyer TONE OUT level.
 - c. replace the control-attenuator.

TELEGRAPH TEST SET TS-2232/UCC-1C(V)

STUDY ASSIGNMENT

NAVSHIPS 0967-046-9010, Technical Manual for Telegraph Terminal AN/UCC-1C(V), pages 4-21 through 4-27

STUDY QUESTIONS

1. List the seven sections of the test set and state the purpose of each.
2. What is the primary control on the test set? What is its purpose?
3. What does the reversals generator do? Where is its output applied?
4. What is the purpose of 2A2R2?
5. What does the tone generator consist of? What is its purpose?

AN/UCC-1C(V) Test Set

INTRODUCTION

The Portable test set used for alignment and test of the other Telegraph Terminal units and provides facilities for:

1. Lone level measurements.
2. Loop current measurements.
3. Reversals generation.
4. Converter phase-distortion alignments.
5. Audible-signal tracing (with speaker).
6. Mark & Space tone generation of 16 narrow band and 4 wide band channels.

REFERENCE

NAVSHIPS 0967-046-9010 Technical Manual for Telegraph Terminal
AN/UCC-1C (V)

INFORMATION

TEST SET CIRCUIT DESCRIPTION.--(See Block Diagram)

The Test Set consists of a reversals generator, a tone generator, an audio amplifier and loudspeaker, a meter, switches to control operation, and a power supply circuit. The FUNCTION SELECTOR switch is the primary control of Test Set operation. It determines the connection and routing of input and output signals. Because, in various positions, it functions with the various circuits in the Test Set, these positions will be discussed with the circuits they affect.

REVERSALS GENERATOR.--The reversals generator consists of a free-running multivibrator driving a transistor switch output circuit. The active element of the multivibrator is an integrated circuit differential amplifier 2A2IC1. The MODE SELECTOR switch S1 determines the mode of operation of the reversals generator, controlling the timing circuitry and providing loop closure to pins A and P of the test connector P1. The positions of S1 and the functions of the reversals generator are as follows:

1. 75 BAUD, the reversals generator runs at 75 baud as determined by R2.
2. 150 BAUD, the reversals generator runs at 150 baud as determined by R1.
3. MARK, S1 closes the loop through R16.
4. SPACE, S1 opens the loop.

The reversals output is available at the test connector only when the FUNCTION SELECTOR switch is in the REV. OUT position.

TONE GENERATOR.--The tone generator consists of crystal-controlled oscillator 2A3IC1 12 frequency control crystals, eight integrated circuit flip-flops (2A1IC1 through 2A1IC8), and a feedback circuit consisting of pulse amplifier 2A2Q3 and diodes 2A1CR1 thru 2A1CR56.

Seven of the eight integrated circuit flip-flops make up a variable seven-stage counter (count down or frequency divider) circuit. The function of the eight stage (2A1IC8) is slightly different from the others; it functions as a frequency divider with a symmetrical output. The frequency division is changed by the TONE SELECTOR switch as required to obtain the correct frequency for the channel selected. Refer to the schematic diagram of the Test Set,

The variable seven-stage counter functions in the following manner. The first four stages 2A1IC1 through 2A1IC4 are always in the circuit. Switching determines whether the output is taken from stage four, five, six or seven. Feedback from the output stage is applied to previous stages to alter the count. For example, take the case in which the total frequency division required is 240. The symmetry flip-flop 2A1IC8 divides the counter output by two, so the counter must divide the oscillator frequency by 120. The seven-stage counter divides by 128. when no feedback is used. A feedback numeral count of eight must be added to cause the counter to divide by 120. This is accomplished by applying the feedback to the fourth stage 2A1IC4. Other counting combinations are obtained by switching, which changes the output stage and the feedback combination. In each combination, the feedback is applied through feedback amplifier 2A2Q3 and steering diodes 2A1CR1 through 2A1CR56.

A number of the frequencies (tones) generated by the Test Set differ slightly from the actual mark and space frequencies. This difference is the result of using frequency division to generate more than one tone from one crystal oscillator frequency. For example, the frequency of 2Y2 (91.840 kc) can be divided by 144 to obtain a frequency of 637.8 cps, or by 80 to obtain a frequency of 1148 cps. Although the output tones of the Test Set are not at the exact frequencies of channel marks and spaces, they are within the tolerances necessary to align the AN/UCC-1C (V).

The TONE SELECTOR switch S4 connects two crystals (one for the space frequency, the other for the mark frequency) into the tone generator circuit. Twenty channel frequencies from 425 cps to 3230 cps are available upon command of the TONE SELECTOR switch. Since each channel has both a mark frequency and a space frequency, a total of 40 frequencies must be derived from the 12 crystals. The TONE SELECTOR SWITCH also alters the configuration of the network of feedback diodes to cause the flip-flop counter to produce the required mark and space frequencies.

The MODE SELECTOR switch (in MARK or SPACE position) connects one of the two crystals, selected by the TONE SELECTOR switch, into the oscillator circuit, at one time. If the MODE SELECTOR switch is in either 75 BAUD or 150 BAUD position, both mark and space crystals are removed from the oscillator circuit.

The tone outputs are connected to pins M and P of the test connector P1 when the FUNCTION SELECTOR switch is in the TONE OUT position.

AUDIO AMPLIFIER AND LOUDSPEAKER.-Tone signals applied across pins N and L of the test connector are connected to input transformer T2 when the FUNCTION SELECTOR switch is in the TONE IN position. The input transformer drives audio amplifier 2A2Q2B through emitter follower 2A2Q2A.

The output of the audio amplifier 2A2Q2B is capacitively coupled by 2A2C4 to the loudspeaker LS1 and also to AMPLIFIER OUT jack J2. This arrangement provides an audible indication of the presence and Keying of signals through the loudspeaker or earphones. Tone signals also may be applied to the AMPLIFIER IN jack J1. In this case, the audible signals are available at LS1 or earphones connected to J2 with the FUNCTION SELECTOR switch in any position.

METER CIRCUITS.--The meter and associated circuits perform a variety of functions as selected by the FUNCTION SELECTOR switch. The mode of operation of the of the meter M1 is determined by the READ-IND. switch S3. When S3 is in the READ position, the parameters selected by the FUNCTION SELECTOR switch are measured in terms of volts, milliamperes, and dbm. When S3 is in the IND. position, the meter provides a go-no go indication with a passing range as indicated in paragraph 3-2a(4).

TONE LEVEL MEASUREMENT.--The tone input to audio-amplifier 2A2Q2B from emitter follower 2A2Q2A is also applied to a rectifier consisting of 2A2CR4 and 2A2CR5. When the FUNCTION SELECTOR switch is set to TONE IN, the rectified signal is applied to the meter. The TONE IN measurement is used for equalizing the output tone levels of the individual channels.

VOLTAGE MEASUREMENTS.--The d-c supply voltage in the modules may be measured by turning the FUNCTION SELECTOR switch to the +12V, -6.8V, and +3V positions. This connects the meter M1 between pins D and P, F and P, or B and P of the test connector through dropping resistors. When the READ/IND switch is in IND position a go-no go indication is obtained; when it is in READ position the meter indicates the actual value in volts.

LOOP CURRENT MEASUREMENT.--When the FUNCTION SELECTOR SWITCH is turned to the LOOP CURRENT position, the meter indicates loop current. Each module contains a resistor in series with the d-c loop. The voltage which is proportional to loop current is applied to pins A and C of the TEST connector of the module. This voltage is coupled through the test connector of the Test Set, dropping resistor, and the LOOP CURRENT contacts of the FUNCTION SELECTOR switch, to the meter.

DELAY ADJUSTMENT.--The phase angles of the channel signals applied to pin A of the test connector and to the PHASE ADJ test point are compared by a delay comparison network. The d-c component of the output of this network is proportional to the difference in phase of the input signals and dependent in polarity upon which channel has the greater delay. The output of the delay comparison network is applied to meter M1 through the FUNCTION SELECTOR switch when it is set to PHASE LO or PHASE HI. The delays of the two channels may be equalized by adjusting the modules to obtain a zero indication on the meter.

CHECKING THE TS-2232 TEST SET CIRCUITS

INTRODUCTION

Testing the test set circuits is a maintenance routine performed as a part of calibration and semi-annually as a part of the POMSEE for the equipment.

EQUIPMENT

Hewlett-Packard Power Supply Model 721A

Fluke Model 825A-G Differential Voltmeter

ME-6D/U Electronic Multimeter

AN/URM-127 Audio Oscillator

AN/USM-207 Frequency Counter

REFERENCES

NAVSHIPS 0967-046-9010 Technical Manual for Telegraph Terminal AN/UCC-1C(V), page 4-21 paragraph f. through page 4-27 paragraph 4-5.

NAVSHIPS 0967-046-9030 Maintenance Standards Book (MSB) for Telegraph Terminal AN/UCC-1C(V), page 2-3 steps 1 through 5 and page 2-4 step 8.

JOB STEPS

Step 1. Complete step 1 on page 2-3 of the MSB.

Step 2. Have instructor check work before proceeding. Initial_____

Step 3. Complete step 2 on page 2-3 of the MSB.

Step 4. Have instructor check work before proceeding. Initial_____

Step 5. Complete step 3 on page 2-3 of the MSB except that FUNCTION SELECTOR should be set to +3V not +12V. This is a typographical error.

Step 6. Have instructor check work before proceeding. Initial_____

Step 7. Complete step 4 on page 2-3 of the MSB.

Step 8. Have instructor check work before proceeding. Initial_____

Step 9. Complete step 5 on page 2-3 of the MSB.

Step 10. Have instructor check work before proceeding. Initial_____

Step 11. Make the test set-up for step 8 on page 2-4 of the MSB and measure the space frequency.

Step 12. Have instructor check work before proceeding. Initial_____

Step 13. Measure the mark frequency.

Step 14. Have instructor check work before proceeding. Initial_____

SELF-TEST ITEMS

The following self-test items have been developed to help you determine how well you understand the maintenance routine described in the job sheet and related information. Place a circle around the letter preceeding the correct answer.

1. Steps 1 through 7 use a common approach which differs from the approach used in step 9. What is the significant difference?
 - a. In steps 1 through 7, DC voltages are measure ; in step 9, an AC voltage is measured.
 - b. Different test equipment is used.
 - c. In one approach accurate calibration inputs are furnished and the readings are taken from the test set meter; in the other the input is adjusted to obtain a particular indication on the test set meter and the input is measured.
2. The results obtained in steps 1 through 5 have been within tolerance; the meter indicates zero volts for step 7. What is the probable cause?
 - a. the meter failed.
 - b. R26 circuit is open.
 - c. R25 circuit is open.
 - d. R29 circuit is open.
3. In self-test item 2, would you be able to learn anything about the cause of the trouble by flipping the READ/IND switch to IND position?
 - a. Yes.
 - b. No.
 - c. Perhaps.

Voice Controlled Relay C-4621/SR

STUDY ASSIGNMENT

Information Sheet 1-N4-7-1I, Voice Controlled Relay C-4621/SR

STUDY QUESTIONS

1. Explain how a submarine communicates with a distant shore station via a relay ship which is equipped with Transmitter Control C-4621/SR.
2. Describe the function of the transmitter modulation level controls, R125 and 126.
3. Explain how hold controls R109 and R119 compensate for pauses in speech.
4. Explain the functions of trip controls R114 and R120 in terms of receiver noise and signal voltages.

5. Explain simplex and duplex operation in terms of transmitter keying.

6. Refer to figure 1-3 and explain how S103 provides for simplex and duplex.

7. Refer to figure 1-3 and explain how K101 is controlled, starting with the audio input at TB 101 and tracing the signal to the grid of V103A. Assume no input at TB 102 and S103 in position shown.

VOICE CONTROLLED RELAY C-4621/SR

INTRODUCTION

The purpose of this information sheet is to provide information from NAVSHIPS 94794 Technical Manual for Control Transmitter C-4621/SR

REFERENCES

NAVSHIPS 94794 Technical Manual for Control Transmitter C-4621/SR

INFORMATION

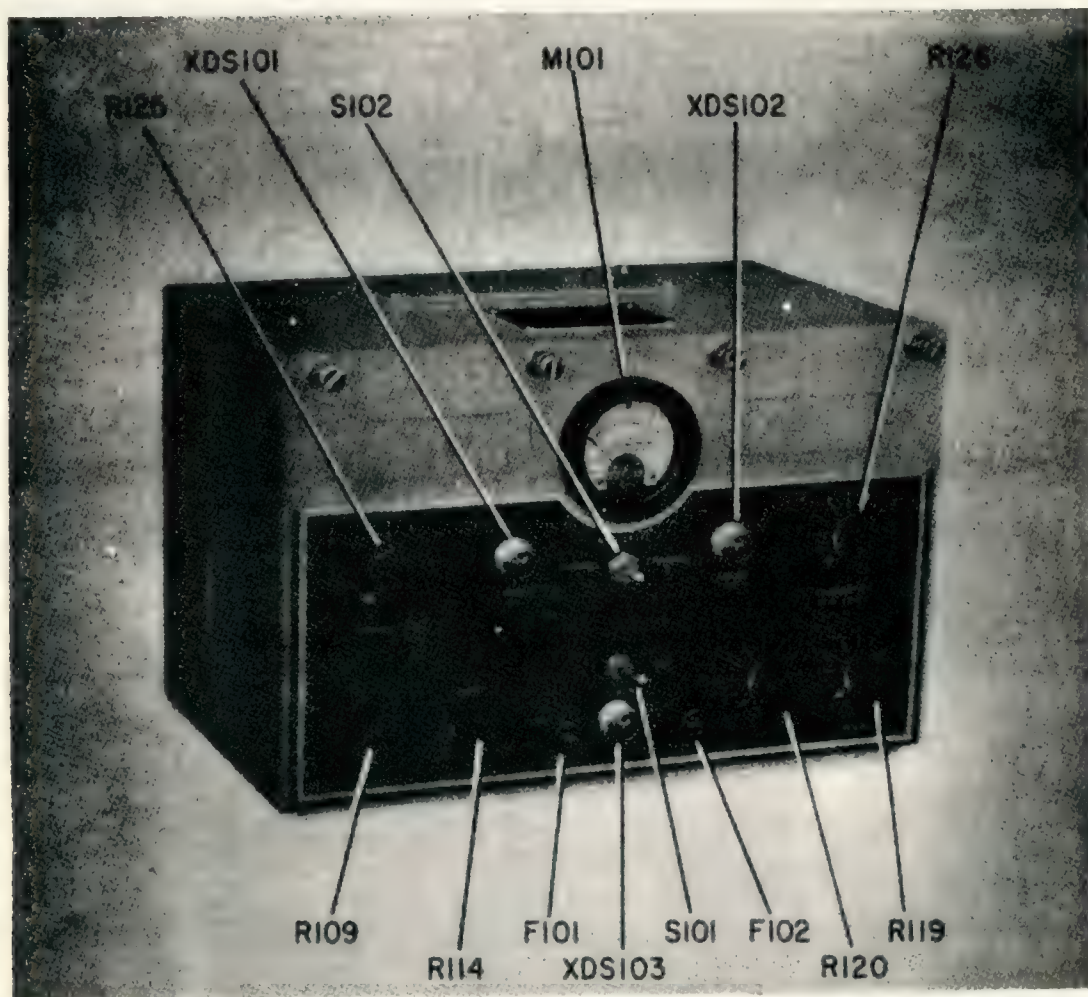


Figure 1-1. Control, Transmitter C-4621/SR

The C-4621/SR is capable of simplex (when one transmitter is keyed, the other cannot be keyed) or duplex (unrestricted keying of either transmitter) operation.

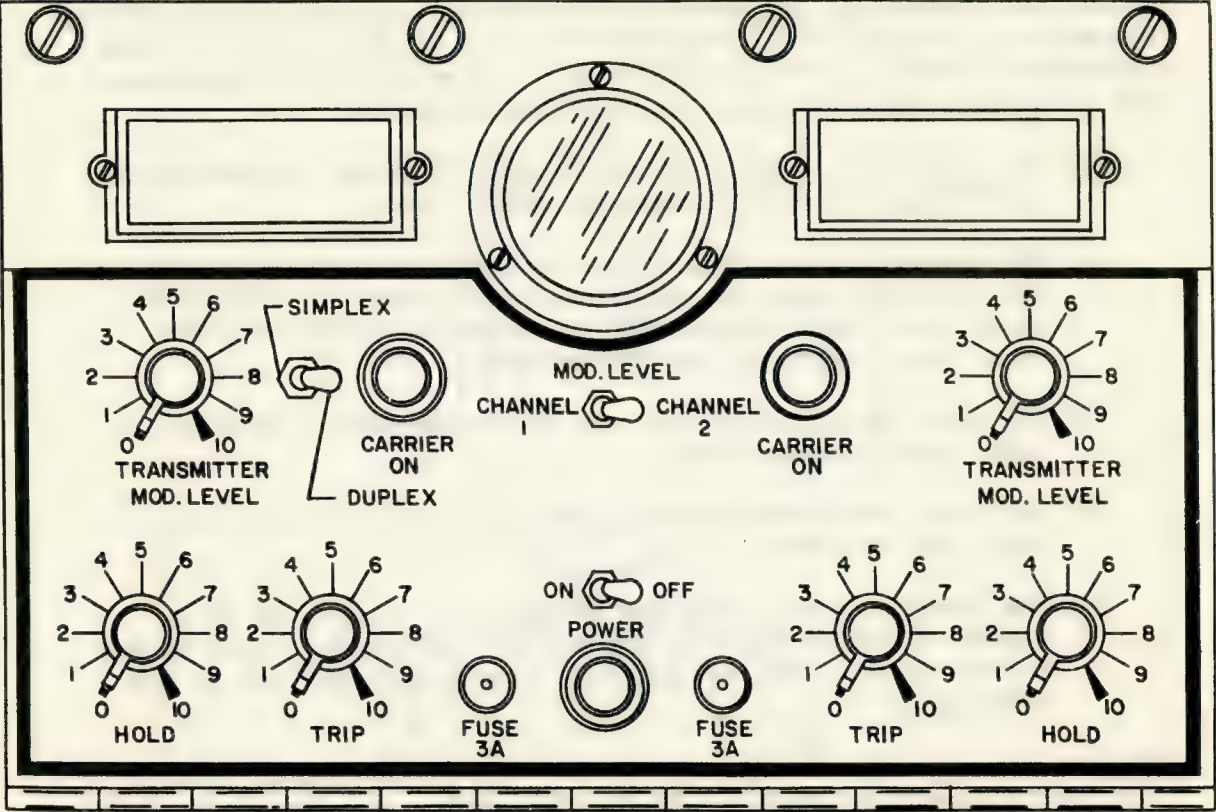


Figure 1-1. Control, Transmitter C-4621/SR

FUNCTIONAL DESCRIPTION

Control, Transmitter C-4621/SR (figure 1-1) is a general purpose equipment which functions primarily as an audio relay. It is designed for use with standard Navy receivers and transmitters and allows received audio to key and modulate a local transmitter. The Control handles one channel of information consisting of two receivers and two transmitters. Figure 1-2 shows basically how it functions in a communications system. In the example shown, a submarine communicates with a distant shore station in the following manner:

- (a) The submarine, using a line-of-sight UHF band, transmits to a UHF receiver aboard a nearby relay ship.
- (b) The received audio from the ship's UHF receiver is routed to the receiver input of the Control unit where it operates a relay which energizes a high frequency transmitter. The same audio modulates the transmitter.
- (c) The shore station receives the HF transmission and replies with its HF transmitter.
- (d) The relay ship receives the shore station's HF transmission on an HF receiver.
- (e) The received audio from the HF receiver is applied to a second receiver input on the Control unit and is used to key and modulate a UHF transmitter, completing the link to the submarine.

The Control unit allows only one of the two transmitters connected to it to be keyed at a time, thereby eliminating the possibility of simultaneous transmission.

The Control, of course, may be used in other systems, such as line-of-sight links for UHF or VHF communications, and aircraft-to-ship-to-shore communications.

The Control is interconnected with shipboard communications equipment through the standard Navy patch panel.

QUICK REFERENCE DATA

Power requirement - 60 cycles, 115 volts, single phase
Number of channels - One (two receivers and two transmitters connected as relays)
Operation - Automatic (completely unattended)

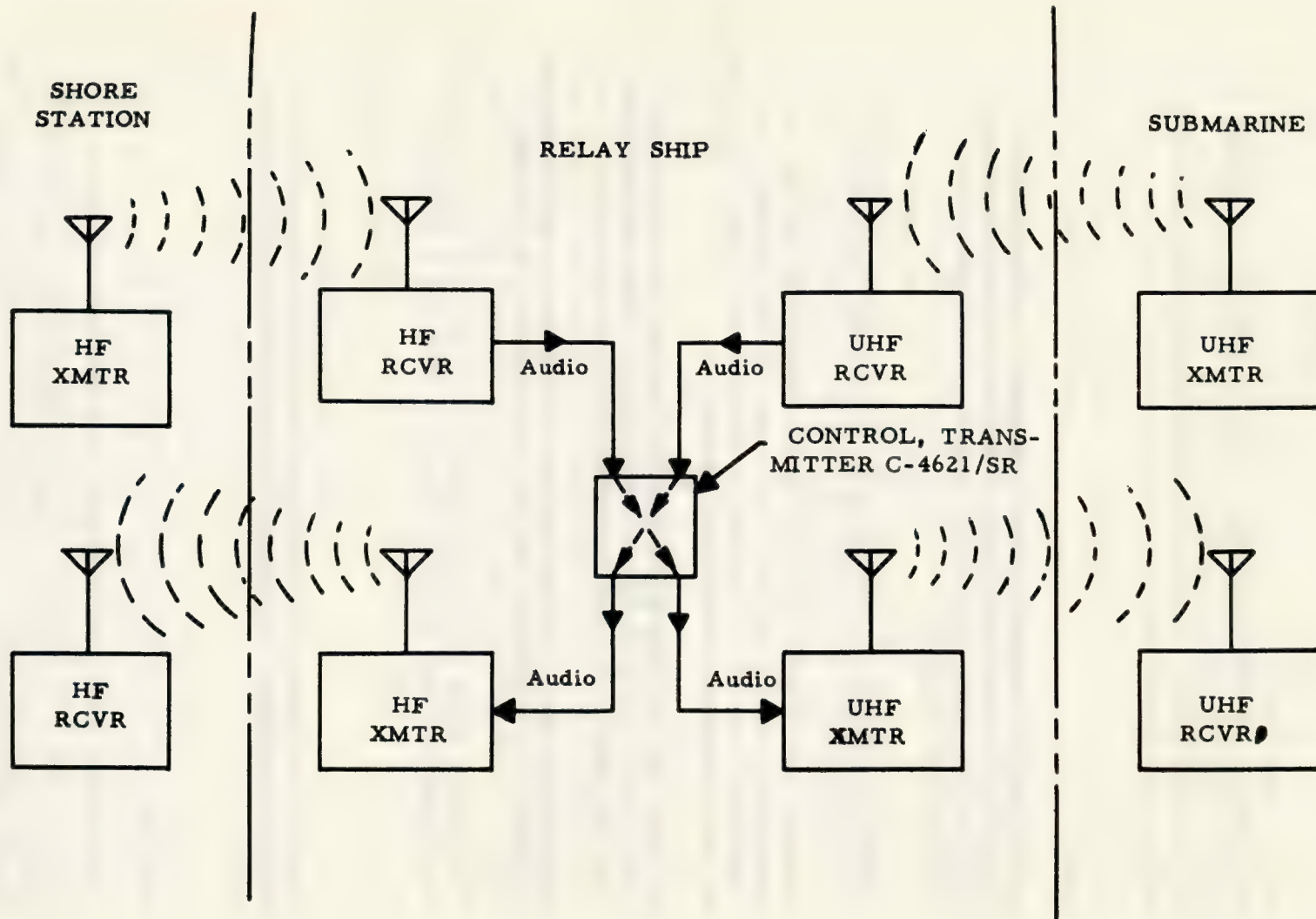


Figure 1-2. System Block Diagram

LOCATION

Control, Transmitter C-4621/SR may be placed on any flat surface, such as a shelf, table, equipment rack or bench. It should be installed in an area where outputs from the receivers and inputs to the transmitters are accessible.

INTERCONNECTIONS

Cable access plates are removable from the sides, top and bottom of the case of the transmitter control. The front panel is hinged and is released by loosening the four large knurled and slotted screws at the top of the panel.

- (a) Connect a source of 115 volt, 60 cycle AC power to terminals 1 and 2 of TB103 on the inside bottom of the cabinet.
- (b) Connect the balanced audio from the channel 1 receiver to terminals 1 and 2 of TB101 (left rear inside cabinet). At terminals 3 and 4 of the same terminal board connect the input to the transmitter modulator (channel 1).
- (c) Connect the balanced audio from the channel 2 receiver to terminals 1 and 2 of TB102 (right rear inside cabinet) and the transmitter modulation input to terminals 3 and 4.
- (d) The keying leads from the channel 1 transmitter are connected to terminals 5 and 6 of TB 101, with terminal 6 grounded.
- (e) The keying leads from the channel 2 transmitter are connected to terminals 5 and 6 of TB 102, with terminal 6 grounded.

POWER

The power supply for Control, Transmitter C4621/SR is completely contained within the cabinet. No external power except the AC supply is required.

FUNCTIONAL OPERATION

Control, Transmitter C-4621/SR operates as a dual-channel audio-operated relay. The unit controls two transmitters in Simplex or Duplex mode of operation by utilizing the detected audio from the receivers. The detected audio also provides the modulating signal for the transmitters. Simplex operation is achieved by grounding one channel of audio when the other channel is active.

FUNCTIONAL OPERATION (CONT')

The control unit is designed for use as a relay between distant sites, and handles one complete information channel. It operates as follows:

- (a) Balanced audio from a receiver is routed to the receiver input of the control unit.
- (b) The received audio is amplified and rectified to provide a negative voltage.
- (c) The negative voltage is used as a control voltage to cut off a vacuum tube which in turn de-energizes a relay. In the de-energized position, the relay closes the keying circuit of the transmitter connected to it, and grounds the audio from the other channel.
- (d) In the absence of audio from the receiver, the tube again conducts, energizing the relay, de-energizing the transmitter and ungrounding the other radio channel.

PREPARATION FOR USE

Control, Transmitter C-4621/SR, is connected to the transmitters and receivers through a standard Navy patch board. Connections to the patch board are made from terminal boards TB101 and TB 102 located at the rear of the control. Terminals 1 and 2 of both boards are the balanced audio inputs from the receivers. Terminals 3 and 4 are the unbalanced audio outputs to the transmitters. Terminals 5 and 6 are the keying lines. Terminals 1 and 2 of TB103 are the AC power input.

OPERATING PROCEDURES

(a) Description of Controls

- 1. ON-OFF Switch (S101) - Controls AC power to Control, Transmitter.
- 2. TRANSMITTER MODULATION LEVEL Controls (R125 and R126) Vary the levels of unbalanced audio output for optimum modulation level. The switch under the meter (M101) selects either channel for setting volume level.
- 3. HOLD Controls (R109 and R119) - Adjust the time constants of the RC networks in the grid circuits of V103. These controls vary the time it takes for the tube to start

OPERATING PROCEDURES (CONT')

conducting after audio is removed from either channel. Normal pauses in speech therefore do not open the transmitter keying circuits. Hold time is adjustable from approximately 100 milliseconds to 1 second.

4. TRIP Controls (R114 and R120) - Vary the biases on the amplifier tubes, hence the gains. This provides a way of varying the negative voltages on the grids of V103 and allows the sensitivity of the circuit to be adjusted so that the relays (K101 and K102) are not activated by receiver noise. These controls allow the relays to be actuated by signal voltages ranging from approximately 0.6 volts to 2.2 volts rms.
5. SIMPLEX-DUPLEX switch (S103)-Selects simplex or duplex mode of operation.

(b) Indicators

1. CARRIER ON Lights (I101 and I102) - Indicate which channel is being keyed.
2. POWER Light (I103) - Glows when the power switch is thrown to the "ON" position.

(c) Operation

1. Connect Control, Transmitter C-4621/SR as previously described. However, do not energize the transmitter yet.
2. Turn the POWER switch on.
3. Turn the channel 1 receiver on and tune a signal.
4. Set the TRIP control so that the relay opens on a received audio signal, but not on receiver noise. CARRIER No. 1 indicator light glows when channel 1 relay is de-energized.
5. Set the HOLD control so that the relay remains open during normal pauses in speech.
6. Set the MODULATION LEVEL switch to CHANNEL 1.
7. With the channel 1 TRANSMITTER MOD. LEVEL control, set the modulation level to 0 db on the meter.
8. Follow the same procedure for setting channel 2.

OPERATING PROCEDURES (CONT')

The Control is now ready for use and the transmitters may be energized.

No further operating procedures are required once the control is connected and properly adjusted. Relay operation is completely automatic.

THEORY OF OPERATION

Control, Transmitter C-4621/SR is a voice operated, vacuum-tube controlled relay. Assuming channel 1 to be the active channel, the sequence of operation is as follows (refer to figure 1-3):

- (a) Balanced audio from a receiver is applied to the "L" pad modulation level control (R125). Unbalanced audio from the "L" pad is fed through a transformer to the patch panel where it is applied to the transmitter as modulation.
- (b) Part of the received audio is applied to the grids of a dual triode (V101) where it is amplified. The amplified audio is rectified by CR101 and CR102 to provide a negative DC voltage to control tube V103A. HOLD potentiometer R109 varies the time constant of the grid circuit of V103A, and therefore, the time it takes for V103 to return to a conducting state after audio is removed from that channel.
- (c) Control tube V103A is in a normally conducting state with no audio applied to the channel, allowing current to flow through the coil of relay K101 and keeping it energized.
- (d) When audio is applied to the channel, the negative voltage appearing at the grid of V103A drives it into cutoff, removing the current from the relay coil and de-energizing the relay.
- (e) De-energized, the relay completes the keying circuit through K101-6 and 5, and K102-13 and 12.
- (f) The grid of V103B is grounded through K101-11 and 12. This prevents rectified audio from reaching the grid of V103B and permits V103B to continue conducting and holding K102 in its energized position. Contacts K101-8 and 9 apply 6.3 volts to I101, a green lamp, to show that channel 1 is active.

THEORY OF OPERATION (CONT')

- (g) The TRIP potentiometer R114 in the cathode circuit of V101 varies the bias on the tube (hence the gain) and provides a means of varying the DC level on the grid of V103A. This control allows the sensitivity of the circuit to be set to prevent V103A from being cut off by receiver noise.
- (h) When audio is no longer present at the input terminals of channel 1, V103A again conducts, energizing K101, opening the keying line, disconnecting the voltage from the indicator light, and ungrounding V103B.

The second channel, consisting of V102 and V103B, operates in the same manner.

TROUBLE SHOOTING PROCEDURE

Table 1-1 is designed to aid in trouble-shooting Control, Transmitter, C-4621/SR.

<u>SYMPTOM</u>	<u>PROBABLE CAUSE</u>	<u>CHECK</u>
1. POWER ON lamp I103 does not glow when POWER switch is in ON position.	1. Loose connection on power input cable. 2. Line fuse F101 or F102 blown. 3. Lamp I103 defective.	Check corrections on TB103 Remove from holder and inspect. Do not replace until cause of overload is ascertained.
2. Relay K101 remains de-energized without audio signals from receiver.	1. V103A defective 2. Relay K102 defective	Check V103 Check continuity of relay winding.
3. Relay K102 remains de-energized without audio signals from receiver.	1. V103B defective 2. Relay K101 defective	Check V103 Check continuity of relay winding.
4. Mod. Level meter M101 can't be set to 0 db by TRANS. MOD. LEVEL control. Received signal is OK.	1. Channel 1 A. Connections to TB101 loose or damaged. 2. Channel 2 A. Connections to TB102 loose or damaged. 3. Transformer T101 damaged.	Check connections visually Check connections visually Check continuity of windings

TROUBLE SHOOTING PROCEDURE (CONT')

<u>SYMPTOM</u>	<u>PROBABLE CAUSE</u>	<u>CHECK</u>
5. Received signal does not de-energize K101.	1. Rectifier CR101 or CR102 defective. 2. V101 defective. 3. HOLD control R109 improperly set.	Check with ohmmeter Check V101. Reset per operating instructions.
6. Received signal does not de-energize K102.	1. Rectifier CR103 or CR104 defective. 2. V102 defective. 3. HOLD control R119 improperly set.	Check with ohmmeter. Check V102. Reset per operating instructions.

COMMUNICATIONS SYSTEMS

STUDY ASSIGNMENT

Information Sheet 1-N4-8-11

STUDY QUESTIONS

1. What is the minimum number of SB-82/SRR Receiver Transfer Switchboards required in the following?
 - a. 5 receivers and 10 remote stations
 - b. 7 receivers and 10 remote stations
 - c. 10 receivers and 15 stations
2. In a system similar to that shown in figure 2, what would be the result if S6 and S9 were closed at the same time?
3. Must SB-82/SRR Transfer Switchboards always be mounted in position shown in figure 1? Explain.
4. In a system similar to that shown in figure 4, what would be the result if both stations 1 and 2 had their selector switches on position 1? Explain how this could be advantageous.
5. How many SB-863/SRT Transfer Switchboards are required for a system of 8 remote stations and 15 transmitters?

6. In a system similar to that shown in figure 7, you measure 115 Volts AC at terminals 1 and 2 of the Remote Radio phone unit terminal board but cannot energize the equipment from that location. What could be the trouble?

7. Refer to figure 7 and draw a schematic of the keying circuit in the radio phone unit starting with -12 volts at terminal 7. Include the primary and secondary of T2, K4, and the extension handset jack in the radio unit. Explain the function performed by each of the three contacts of K4.

8. Describe the path the audio takes from the speaker's voice at the remote phone unit handset mike to the 5 and 6 winding of T1 in the transmitter.(figure 7).

9. Why is -12 volts available at terminal 7 of the radio phone unit? (figure 7).

10. When the handset is used with the phone unit shown in figure 8, and the push to talk button is pressed, K101 is energized. List the three functions performed by this relay.

11. Name the three basic circuits controlled by standard remote phone unit C-1138A/UR.

12. In the diagram shown in figure 9, from where is the audio obtained that is controlled by R103?

13. In the diagram shown in figure 9, what function is performed by the 2 and 4 contacts of K101 when it is energized?

14. What three functions are performed by 4 and 6 wire control circuits at remote keying stations?

15. In the Navy Type 23005 Control Circuit, what function is performed by K1?

16. To what type of transmission would the Navy Type 23005 and 23146 Control Circuits be limited?

17. What is the danger in plugging a patch cord into a looping jack and holding the free end?

18. Explain why a patch cord can be plugged into a set jack and the free end held without any danger.
19. In figure 14, where would a TTY printer be connected to be "normalled up"?
20. In figure 14, if a TTY printer were connected to terminal 1 and 2 of TB 103, how would this machine be patched into the loop?
21. Why are antenna multicouplers required aboard Naval vessels?
22. In the system shown in figure 22, what is the minimum number of DC loops required on the TTY panel?
23. Explain the difference between space and frequency diversity.
24. Explain the difference between On line and off line crypto system.

COMMUNICATIONS SYSTEMS

STUDY ASSIGNMENT

Information Sheet 1-N4-8-11

STUDY QUESTIONS

The blocks shown in figure 1 represent equipment you have studied. In the systems specified below, certain blocks are indicated and represent the equipments for the system desired. To the right of the block number list the equipment, along with its correct nomenclature, that would be used in the following systems:

TTY FSK receiving system with space diversity

- 1.
- 3.
- 4.
- 5.
- 7.
- 12.
- 14.

TTY FSK send system with frequency diversity

- 14.
- 12.
- 11.
- 15.
- 16.

Tone modulated UHF send system with non diversity

6.

12.

8.

11.

17.

Tone modulated UHF TTY receive system with non-diversity

4.

5.

8.

12.

6.

TTY two channel send system with RF frequency diversity using SSB.

10.

13.

9.

11.

15.

16.

TTY tone receive system with RF frequency using SSB.

1.

2.

3.

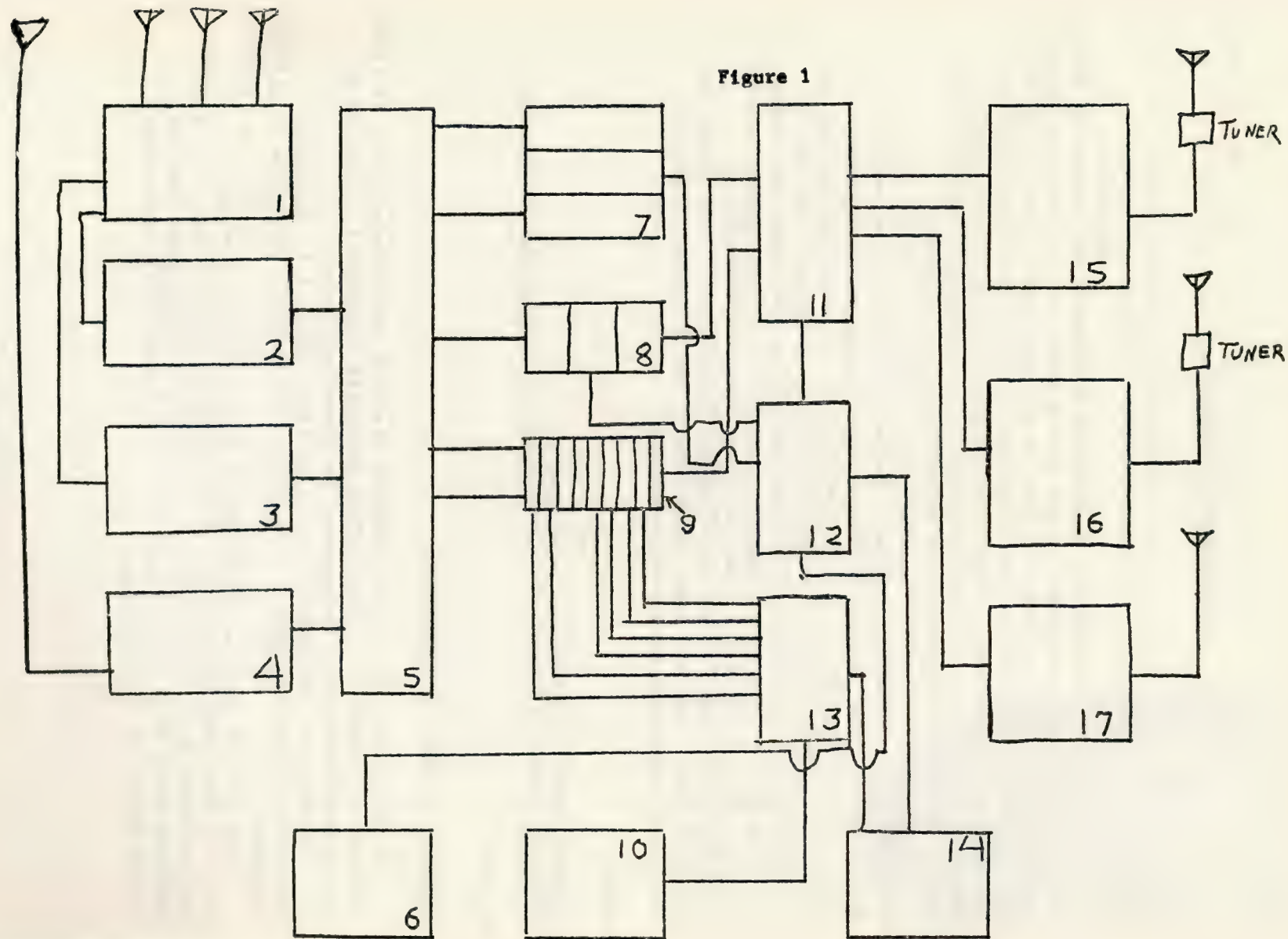
5.

9.

13.

10.

Figure 1



COMMUNICATION SYSTEMS

INTRODUCTION

Shipboard communications electronics equipments are located in various parts of the ship, sometimes to the extent that the operating positions are completely removed from the rest of the equipment. Because of this it is necessary to provide remote control units so that the operator can control the equipment without walking the length of the ship. In order to connect all units together in an integrated communications system various patch panels and switchboards are required.

Radio remote-control transfer plug panels have become too cumbersome to be used in shipboard radio installations on modern Navy ships. Therefore, control panels utilizing switches instead of plugs and patchboards are being installed in new construction and in conversion jobs. Constructed panels (one for receivers and one for transmitters) now provide all of the facilities that were available in plug panels, and afford greater flexibility in the remote-control system. Two of these units are Receiver Transfer Switchboard, Type SB-82/SRR, and Transmitter Transfer Switchboard, Type SB-863/SRT. You will find older and newer switchboards but the basic principles for all of them will be about the same.

REFERENCES

NAVPERS 10188F Electronics Technician 3
NAVSHIPS 94200, 1-2 Directory of Communication equipment (supplement 2)

INFORMATION

RECEIVER TRANSFER SWITCHBOARD

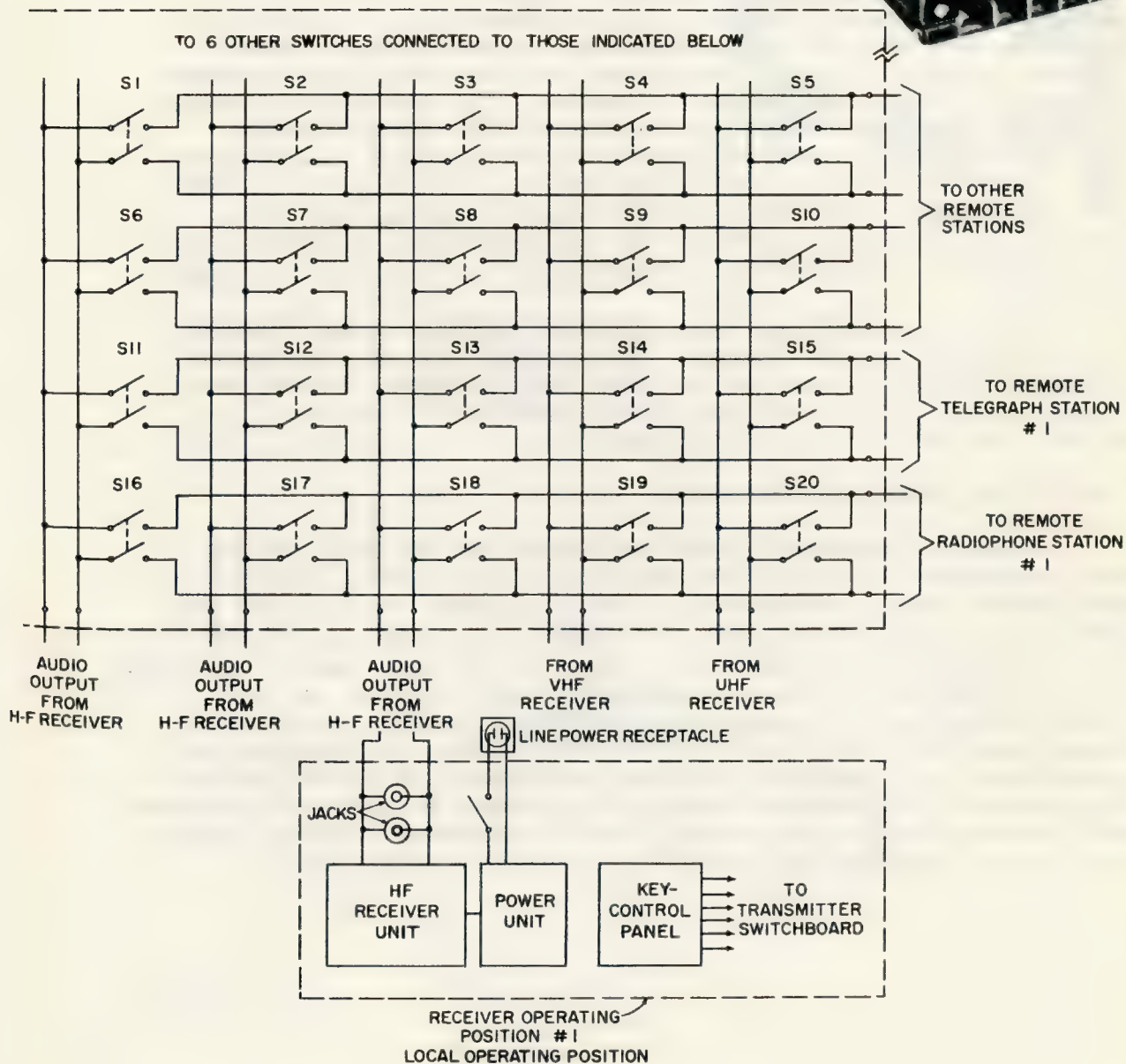
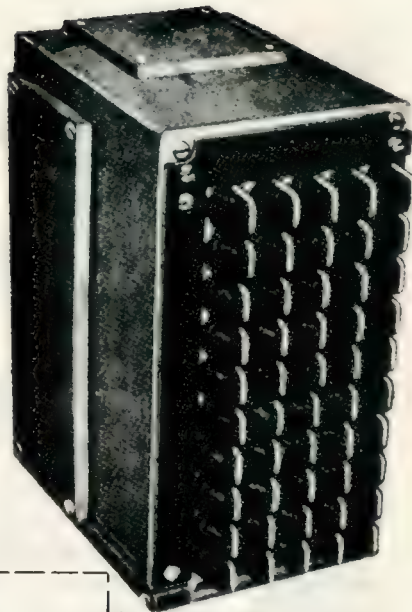
An external view of the Receiver Transfer Switchboard, Type SB-82/SRR is shown in figure 1. A simplified schematic diagram of a portion of the internal switching arrangement is shown in figure 2.

The receiver switchboard has 5 vertical rows of 10 double-pole, single-throw (ON-OFF) switches that are continuously rotatable in either direction.

One side of each switch within a vertical row is wired in parallel horizontally with the corresponding sides of each of the other four switches in a horizontal row. This method of connecting the switches gives rise to the term CROSS-MAT PARALLELING, and permits a high degree of flexibility.

Figure 1. External view of the Receiver Transfer Switchboard type SB-82/SRR.

Figure 2. Simplified schematic diagram of the receiver transfer switchboard type SB-82/SRR.



The audio output from the receiving equipments, connected to the five vertical rows of switches, may be fed to any or all of the remote stations by closing the proper switch or switches. For example, the audio output from the L-F receiver may be fed to radiophone station No. 1 by closing switch 16; it may be fed to all of the remote stations by closing all of the switches in the left-hand vertical column.

Shielded leads are used for the audio circuits. The knob of each switch is marked with a heavy white line to provide visual indication of the communication setup. In general, there are more remote stations than there are receivers, and therefore the switchboards are normally mounted in a vertical position (as in fig. 1) This arrangement permits the outputs from 5 receivers to be fed to the 5 vertical rows and up to 10 remote stations to be fed from the 10 horizontal rows of switches. Switchboards are furnished with the knobs in the OFF position when the white line is vertical.

If it becomes necessary to employ a system where there are 10 receivers and 5 remote stations, the switchboard may be mounted in a horizontal position and each switch knob rotated 90 degrees with respect to the shaft. All shafts have two flat sides for setscrews so that this change can be made if desired. The purpose of rotating the switch knobs with respect to the shaft is to standardize the setup so that the switches will be in the OFF position when the white line is vertical. To further standardize all installations, receivers are always connected to the vertical rows of switches, and remote stations are always connected to the horizontal rows of switches after the orientation (vertical or horizontal) of the switchboard has been determined.

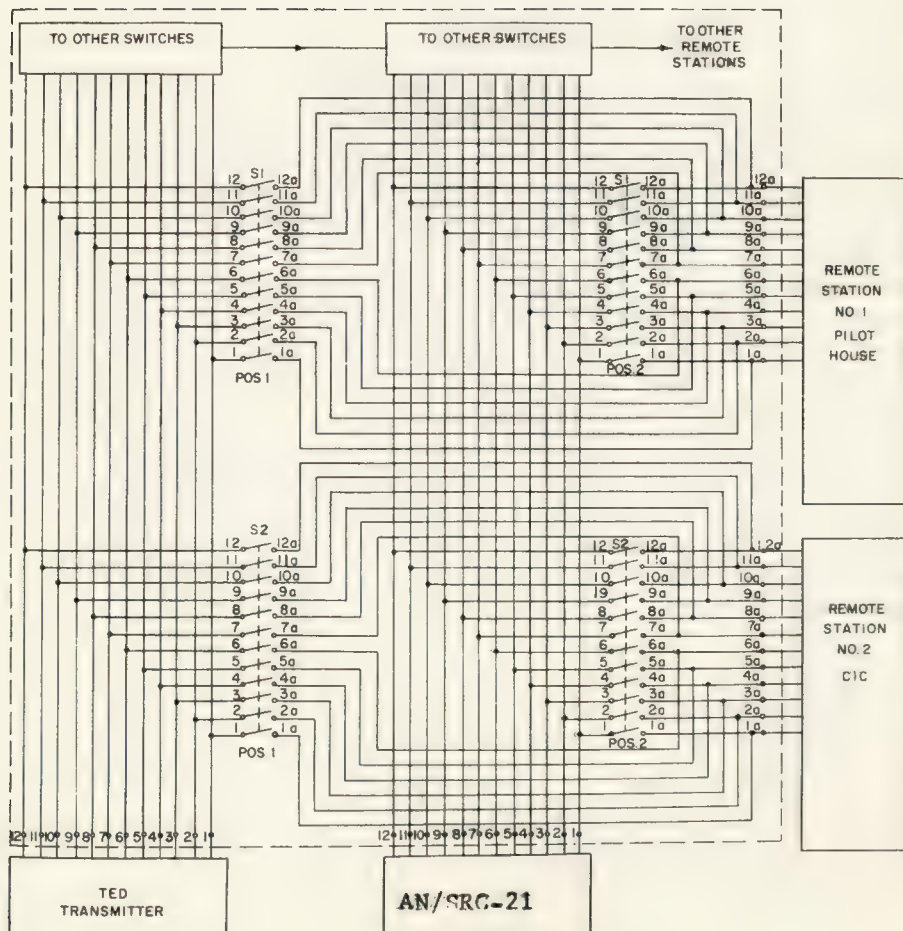
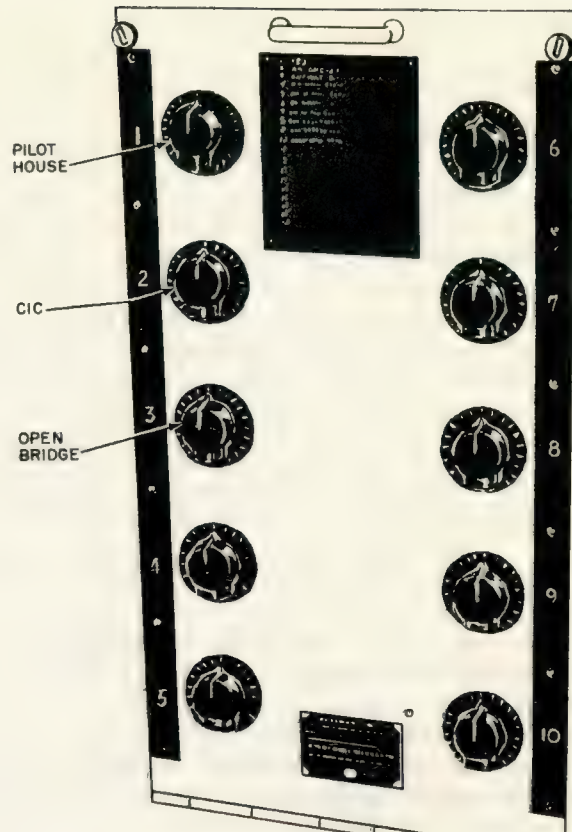
It should be noted that only the receiver audio output circuit is connected to the switchboard. This is true also of the receiver transfer plug panel used in a earlier installations. Transmitter transfer switchboards, however, handle several other types of circuits in addition to audio circuits.

TRANSMITTER TRANSFER SWITCHBOARD

Transmitter Transfer Switchboard type SB-863/SRT (fig. 3) Has ten 20-position rotary selector switches, in two vertical columns. Each rotary switch corresponds to a remote control station, and each switch position (1 through 19) corresponds to a controlled transmitter. Thus switching control is provided for up to 10 remote control stations, and 19 transmitters. When more than 10 remote stations, or 19 transmitters, are to be connected, additional transfer switchboards maybe installed. Position 20 of each rotary switch is provided for connections to an additional transfer switchboard to control extra transmitters. The switches consist of 12 wafers which serve to connect the start-stop indicator, keying, 12-vd-c microphone, carrier control, and carrier indicator circuits for the various transmitters.

Figure 3. Transmitter transfer switchboard-SB-863/SRT

Figure 4. Simplified schematic diagram of transmitter transfer switchboard SB-863/SRT, showing first two positions of rotary switches 1 and 2.



Any of the remote stations may be connected to control any of the transmitters in the system. For example, to connect remote station No. 1 (fig. 4) to control the TED transmitter, rotary switch No. 1 (S1) is placed in position 1. To control the AN/SRC-21 from remote station No. 1, switch S1 is placed in position 2. Switch 2(S2) is used for remote station No. 2 in the same manner.

The remote stations assigned to each rotary switch, and the transmitters assigned to positions 1 through 19, are engraved on the engraving plates when the switchboard is installed (fig.3). If an extra switchboard is installed, switch position No. 1 on the second switchboard is assigned to transmitter No. 20, position No. 2 to transmitter No. 21, etc. Thus, if remote station No. 2 is to have control of transmitter No. 22, switch No. 2 on the first switchboard is placed in position 20, and switch No. 2 on the additional switchboard is placed in position 3.

INTERCONNECTIONS BETWEEN TRANSFER SWITCHBOARDS

Figure 5 illustrates possible interconnections between the various switchboards located in Radio Central, Radio II, and Radio III.

Increased flexibility may be obtained by the use of a large number of switchboards in Radio Central and a smaller number of switchboards in Radio II and Radio III. Most of the space on two bulkheads may be taken up by the switchboards in Radio Central.

SWITCHBOARD, RECEIVER TRANSFER SB-973/SRR

Receiver Transfer Switchboard SB-973/SRR is designed to transfer the audio output of radio communications receivers to remote control station audio circuits. The switchboard contains ten, two circuit, seven position rotary switches connected to a terminal board which has stud type terminals for connecting external incoming and outgoing cables. (See figure 6).

The rotary selector switches are specially designed for instant removal of a damaged or faulty wafer section. Each switch incorporates one printed circuit switch wafer consisting of seven radial contact positions on each side, a contact switching rotary mechanism and printed wiring lead out terminations to engage mating connections in a plug-in receptacle. The wafer assembly is so designed that, by placing the switch operating knob to the "off" position, slots in the wafer and its rotary mechanism are brought into alignment with the operating shaft, permitting the wafer to be withdrawn from its receptacle and replaced without dismantling the switch or removing and connecting wires.

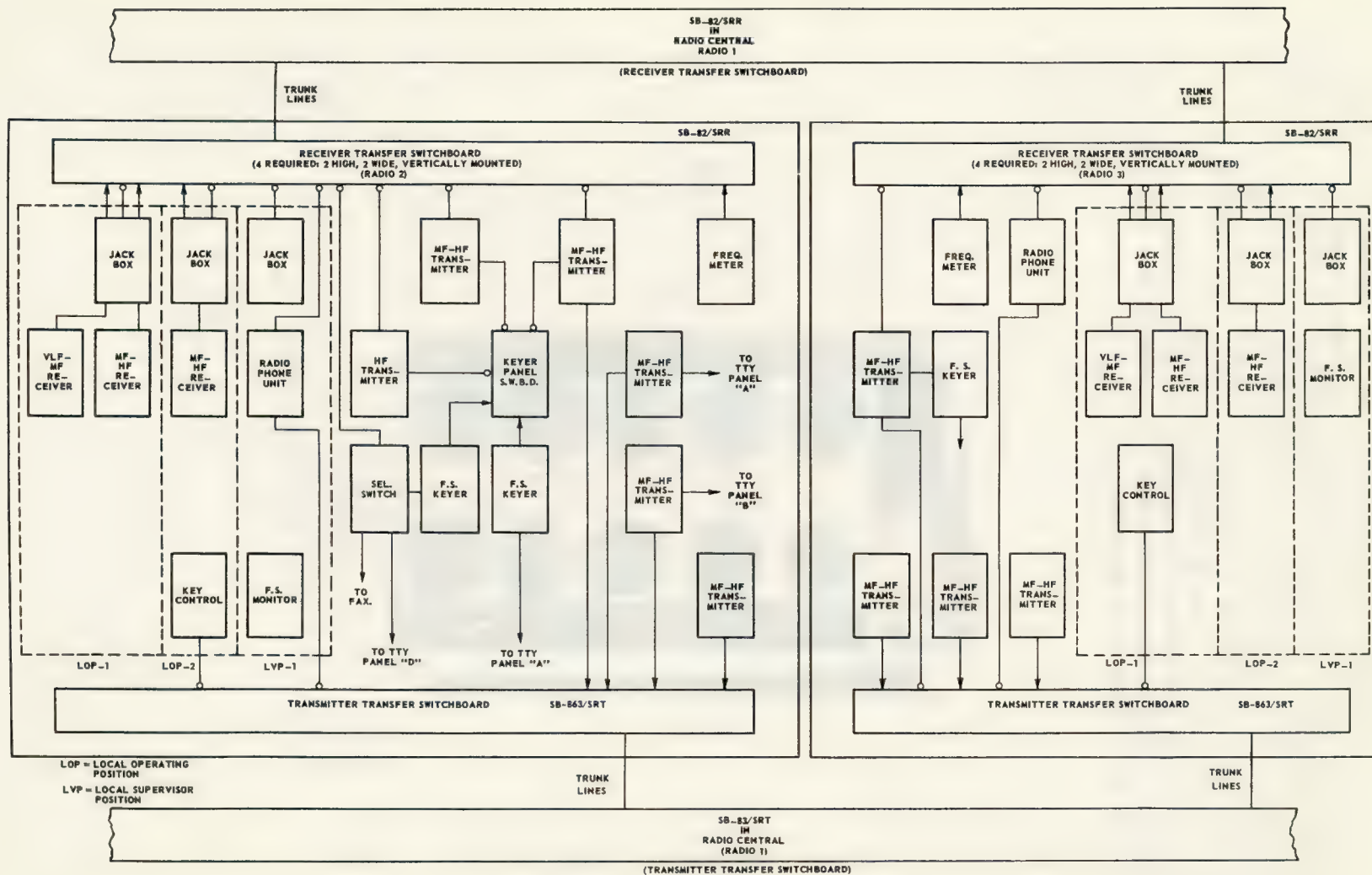


Figure 5 —Interconnections between transfer switchboards.

Receiver Transfer Switchboard, SB-973/SRR, has the purpose of transferring any one of five radio receivers to any one or all of ten remote control stations. Provision is made for connections to additional Receiver Transfer Switchboards, to transfer any number of radio receivers to any number of remote control stations. One additional switchboard is required for each five additional receivers or for each ten additional remote control stations.

The switchboard provides greatly simplified operation when compared with switching systems previously used and reduces the chances of error in circuit selection to a minimum.

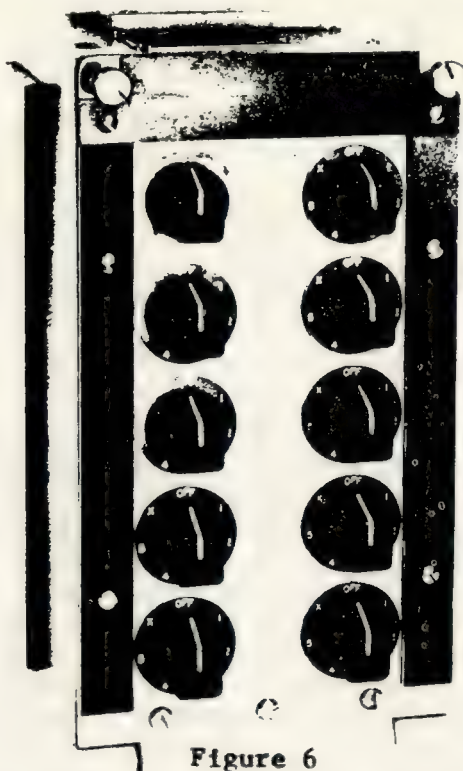


Figure 6

SWITCHBOARD, RECEIVER TRANSFER SB-973/SRR

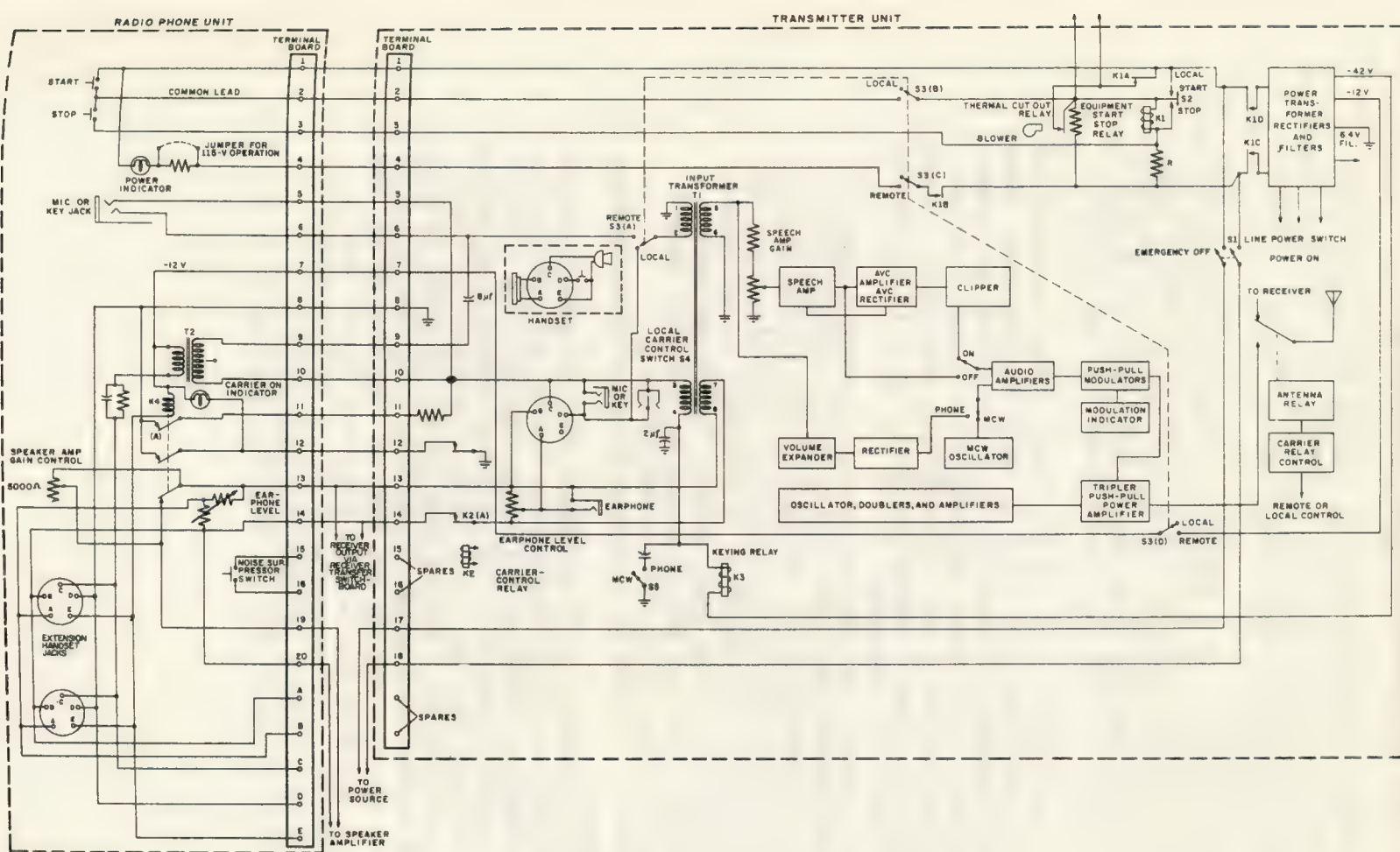


Figure 3- .-Switch connections between radiophone and transmitter.

SWITCH CONNECTION BETWEEN RADIOPHONE UNIT AND TRANSMITTER

Generally, a radio transmitter connects through the transmitter transfer switchboard to a radiophone unit. However, in figure 7 the transmitter transfer switchboard has been omitted; and only a simplified diagram of the transmitter (Navy Model TED-8), showing the control circuits, is included.

The line power switch, S1, is a 2-pole, single-throw switch in the 60-cycle, singlephase, power-line circuit and must be closed before the equipment can be started with the start-stop switch at the transmitter or RPU. In an emergency, power can be quickly removed from the entire equipment by throwing the line power switch to the EMERGENCY OFF position.

The local start-stop switch, S2, in the transmitter is a momentary contact (nonlocking) switch used to start or stop the equipment after S1 has been closed. Momentary closure of S2 on the START side energizes the equipment start-stop relay, K1, which locks itself in the closed position through contacts K1A, the thermal cutout relay contacts, and resistor R. Relay K1 remains energized until its coil is shorted when S2 is moved to the STOP position.

The local remote switch, S3, affords local or remote control of the operation of the transmitter. When S3 is set to LOCAL, S3(a) connects the parallel combination of the local handset, the microphone jack, and the local carrier-control switch in series with the input windings of the input transformer, T1 (winding 1-2 in series with winding 3-4), thus providing local control of the carrier. Indicating and control functions are disconnected from all remote units by operation of S3(a), S3(b), S3(c), and S3(d).

When S3 is turned to the REMOTE position, the following sequence of events takes place:

1. Switch S3(a) connects the T2 secondary and the microphone or key jack in the RPU as a parallel combination across the transmitter T1 Primary (1-2 winding in series with the 3-4 winding) and disables the local carrier-control circuits. The circuits through the handset microphone in the RPU are from the -12-v supply (terminal 7), the T2 primary, terminals C and D of the handset extension jacks by way of the push-to-talk switch (not shown in the RPU), and ground return at terminal 8. The circuits through the handset receiver in the RPU are from terminals A and B of the handset extension jacks, the ear-phone-level potentiometer, and terminals 13-14 to the associated receiver via the receiver transfer switchboard (not shown).

2. Switch S3(b) connects the common lead the stop switch in the RPU.

3. Switch S3(c) connects one side of the 115-vac line to the RPU power indicator by way of terminal 4. The other side of the 115-v line is always connected directly to the other side of the power indicator.

4. By means of S3(d), -12v is applied to the RPU for microphone current.

The audio monitoring circuit involves the circuits connected to terminals 5, 6, 10, 13, and 14 on the terminal board. The audio monitoring circuit enables the operator to listen to the output of the receiver when the transmitter is off and to listen to speech "side-tone" when the transmitter is being used. Circuits are provided so that this may be done either locally or at a remote location. The audio signal from the receiver is brought into terminals 13 and 14.

When the transmitter carrier is off, relay contacts K2(a) are closed (K2 is deenergized), and the audio signal from the receiver is fed via K2(a) to the earphone-level volume control at the transmitter and to the 7-8 winding of T1. The receiver may be monitored locally by plugging the earphones into the earphone jack at the transmitter, because this jack is connected across a part of the earphone-level volume control.

When the transmitter carrier is on, relay K2 is energized and contacts K2(a) are open. This condition disconnects the receiver audio signal circuit from the earphone-level control at the transmitter, the associated earphone jack, the receiver handset plug terminals A and B, and the 7-8 winding of T1. The transmitter sidetone signal is picked up by the secondary, 7-8, winding of T1 and impressed across the earphone-level control for local monitoring. The remote monitoring signal is picked up from the control lines on which the signal is normally present during voice operation.

When S5 is in the PHONE position and the local **microphone handset** press-to-talk switch is operated, keying relay K3 is energized. This action indirectly energizes carrier control relay K2, which disconnects the receiver from T1, as previously described. Thus, the receiver is disconnected when the transmitter carrier is on. The same action takes place in remote operation, except that relay K4 in the RPU energizes K3 by applying ground to terminal 3 of the 3-4 winding of T1 via terminals 8 and 11 and contacts K4(a).

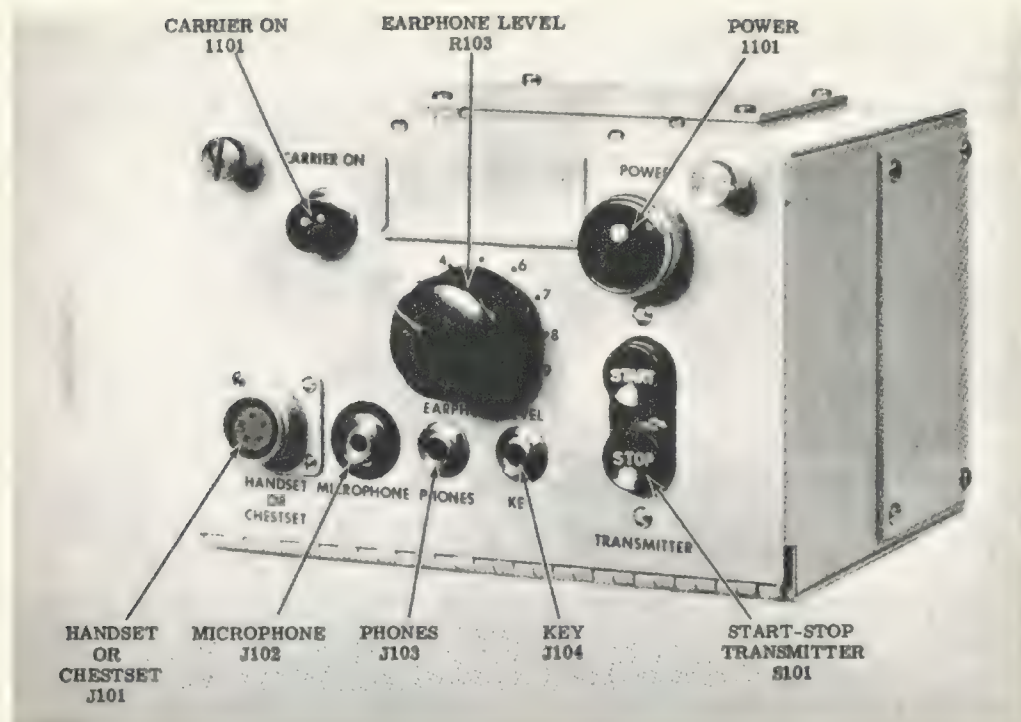


Figure 8. RADIO SET CONTROL, C1138A/ UR, FRONT PANEL

REMOTE PHONE UNIT C-1138A/UR

The purpose of the Remote Phone Unit is to provide necessary facilities to remotely control certain radio-phone transmitter functions and the output of - radio receiver. Incorporated into the circuitry is the means for turning on or off any standard Navy shipboard transmitter, the means to voice modulate (or key when C-W operation is desired) any standard Navy Shipboard transmitter and the means to monitor and control the output of any standard Navy radio receiver. The unit incorporates POWER and CARRIER ON indicators to provide the remote control operator with this information. Under standard operating conditions, as many as four C-1138A/UR Remote Phone Units or similar units may be parallel connected to a single equipment group (transmitter and receiver) to provide various remote operating positions.

The front panel is utilized for the mounting of the normally used controls and the input and output jacks. The front panel is hinged at the bottom and secured at the top by two captive thumb screws. Access to the chassis components is obtained by opening the hinged front panel which swings the chassis out of the unit. An earphone muting control is located on the chassis and is adjusted from the underside of the chassis. Two terminal boards are mounted inside the cabinet on the back wall to provide connection points for the external cabling. This set is capable of being connected in parallel with up to three or more units to provide remote operation of a single equipment group from as many as four different locations.

To energize the controlled transmitter press the START button momentarily. This energizes the starting relay in the transmitter and the POWER indicator is illuminated.

To de-energize the transmitter press the STOP button. This shorts the starting relay coil in the transmitter, de-energizing the starting relay and the POWER indicator.

Depending upon what type of emission is being utilized, the operator may use a key, handset, chestset or microphone (none of which is supplied with this equipment). When voice modulation is used the operator must actuate the push-to-talk switch on the microphone, handset or chestset he is using to connect the microphone in series with the microphone input transformer and actuate the relay which: (1) cuts off the speaker; (2) actuates the push-to-talk relay in the controlled transmitter and; (3) energizes the CARRIER ON indicator at his own and the paralleled control units, indicating that transmitter is in use.

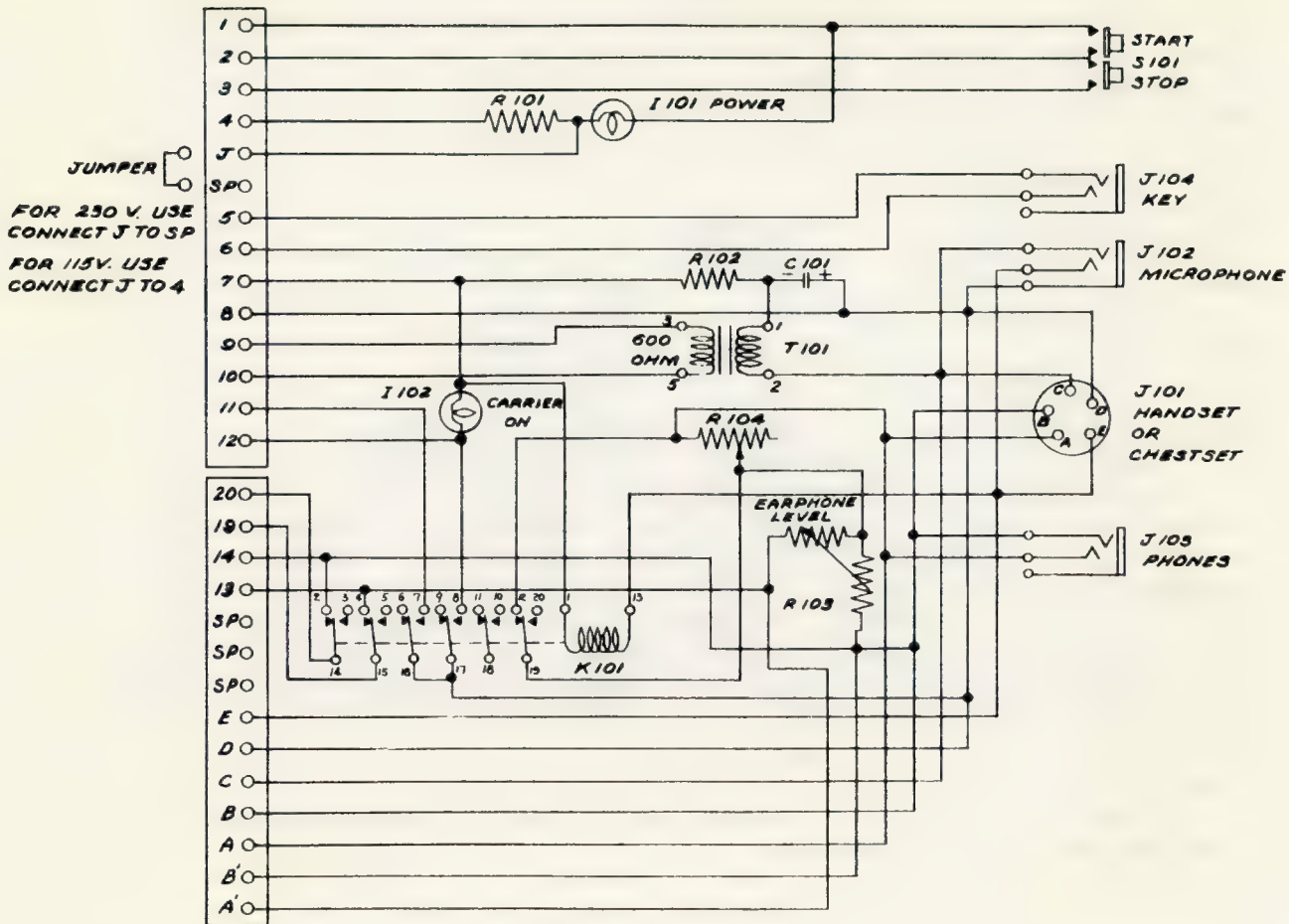
The EARPHONE LEVEL potentiometer is adjusted by each operator to suit his own listening habits.

PRINCIPLES OF OPERATION

The Radio Set Control, Model C-1138A/1R, implements control of three basic circuits. These are namely, transmitter control circuits, the transmitter input circuits, and the receiver output circuits.

The transmitter control circuits consist of the START-STOP TRANSMITTER switch, S101, the associated POWER indicating lamp, I101, the CARRIER ON indicator lamp, I102, and relay K101 which actuates the push-to-talk relay in the transmitter. (See Figure 9)

The transmitter input circuits consists of the HANDSET OR CHESTSET connector, J101, and the MICROPHONE jack, J102, which connects the microphone (not part of unit) in series with the necessary voltage and the primary of the microphone input transformer (T101). Actuating the push-to-talk switch on the microphone, handset or chestset completes the circuit through the microphone input transformer and also completes the circuit which energizes relay K101. Relay K101, when closed, applies the 12 volts necessary to close the push-to-talk relay in the controlled transmitter. The control unit also provides a KEY input jack, J104, which is utilized when C-W operation is desired.



TB-102

TERMINAL	FUNCTION
1	POWER BUS 115/230 V AC OR DC
2	POWER ON CONTROL BUS
3	POWER OFF CONTROL BUS
4	POWER BUS 115/230 V AC OR DC ONE CONNECTION POINT FOR JUMPER PLATE FOR 115 V OPERATION
J	COMMON CONNECTION POINT FOR JUMPER PLATE FOR 115 VOLT OR 230 VOLT OPERATION
SP	SPARE CONTACT USED EXCLUSIVELY FOR JUMPER STOWAGE ON 230 V OPERATION
5	KEY OUTPUT-RING
6	KEY OUTPUT-TIP
7	NEGATIVE 12 V INPUT
8	POSITIVE 12 V INPUT
9	600 OHM LINE-MICROPHONE OUTPUT TO TRANSMITTER
10	
11	
12	POSITIVE 12 V CARRIER ON SIGNAL OUTPUT
13	POSITIVE 12 V CARRIER ON SIGNAL INPUT
14	POWER IS APPLIED TO TERMINAL NO. 4 VIA A SET OF CONTACTS ON THE "STARTING" RELAY OF THE CONTROLLED TRANSMITTER. THE "POWER ON" INDICATOR WILL NOT LIGHT UNTIL THE STARTING RELAY HAS ACTUATED.
13	600 OHM LINE RECEIVER AUDIO INPUT TO CONTROL UNIT
14	
19	RECEIVER AUDIO OUTPUT FOR SPEAKER AMPLIFIER
20	
A'	600 OHM LINE-RECEIVER AUDIO INPUT TO CONTROL UNIT, SAME AS 13 AND 14
B'	
A	600 OHM HEADSET OUTPUT
B	
C	MICROPHONE INPUT, CARBON SINGLE BUTTON
D	
E	POSITIVE 12 V SUPPLY
SPARES	CARRIER ON RELAY CONTROL LEAD
	THREE SETS OF SPARE TERMINALS

FIGURE 9. RADIO SET CONTROL, C-1138A/UR, SCHEMATIC DIAGRAM

The receiver output circuits provide facilities to regulate the audio output level delivered from the remote receiver. THE EARPHONE-LEVEL POTENTIOMETER, R103, is adjusted to provide the desired audio level at the PHONE jack, J103, and pins A and B of the HANDSET OR CHESTSET connector, J101. The muting control R104 provides for adjustment of the input level to the earphone, and pins A and B of the handset or chestset connector, when the microphone input is being used.

The transmitter START-STOP switch, S101, consists of two normally open, push-to-make contact switch circuits. Pressing the START button connects terminals 1 and 2 of terminal board TB-101 through the switch contacts and pressing the STOP button connects terminals 2 and 3 of terminal board TB101 together. (See figure 9). When the unit is connected to a transmitter incorporating the standard Navy shipboard control circuitry, pressing the START button energizes the starting relay in the transmitter. The starting relay when energized closes a pair of contacts the shortthe same wires the START switch does and the transmitter remains energized. Pressing the STOP button shorts the transmitter's starting relay coil through a current limiting resistor, causes the relay to open, and de-energizes the transmitter. Since the START-STOP switches are normally open the transmitter may be energized or de-energized from any parallel connected remote control unit.

Power on indication is provided by the POWER ON indicator lamp I101 located on the front panel. For operation from a 230-volt line, resistor R101 is connected in series with the lamp. The lamp is rated at 230 volts; however, the resistor is connected in series when a 230-volt supply is being utilized to lower the applied voltage to approximately 115 volts. Operating the lamp at half its rated voltage greatly increases its service life. When a 115 volt supply is used the resistor is shorted out of the circuit by the jumper.

Terminal 1 of terminal board TB-101 is connected to one leg of the supply and terminal 4 is connected to the other through a set of contacts of the controlled transmitter's starting relay.

All remote stations are parallel connected and the POWER indicators of all control units in a group are illuminated when power is applied to the controlled equipment group (transmitter and receiver).

The audio circuitry consists of the connectors J101 and J102 which, along with the terminal board, TB-102, provides connection facilities for a carbon microphone, handset or chestset, a microphone to 600-ohm input transformer, T101, a microphone current limiting resistor, R102, a filter capacitor, C101, an L-type constant impedance earphone level attenuator, R103, and an earphone muting control, R104. The secondary of the audio input transformer, T101, connects to terminals 9 and 10 of terminal board TB-101. The voltage necessary to provide microphone current and operate relay K101 is obtained from the transmitter through terminals 7 and 8 of terminal board TB-101. The output of the radio receiver connects through terminals 13 and 14 of terminal board TB-102. The external speaker amplifier (not part of unit) is connected to terminals 19 and 20 of terminal board TB-102.

Push-to-talk circuit. Any microphone, handset or chestset normally used with the control unit provides a manually operated switch which serves to connect and disconnect the microphone without disturbing the connection to the headphone. When this switch is actuated the microphone is connected in series with the positive leg of the 12-volt dc supply and the primary of the audio input transformer. Actuating this switch also connects a third contact to the 12-volt dc supply and thereby actuates relay K101.

The earphone muting and carrier-on indication functions are accomplished by actuation of the six pole double throw relay, K101. It is energized when the push-to-talk circuit is completed. When the relay is energized, two poles are connected directly to the positive leg of the 12-volt dc supply to actuate the push-to-talk relay in the controlled transmitter through the connection at terminal 11 on terminal board TB-101, and energizes the CARRIER-ON indicators of all parallel connected control sets, through the connection provided by terminal 12 of terminal board TB-101. Two poles of the relay are connected to each leg of the audio output line which connects to the external speaker amplifier. Energizing the relay opens the direct connection to the speaker amplifier and electrically connects the earphone muting control, R104, between the receiver output and earphone input, allowing the audio level to be attenuated to the desired degree.

REMOTE KEYING STATIONS

Every Navy transmitter has a control circuit to facilitate turning the equipment on and off, keying the transmitter and giving the operator the indication that the transmitter is either on or off.

Two of the different types of control circuits are the Navy type 23005 four wire control circuit and the Navy type 23146 six wire control circuit.

In figure 10, the four wire control circuit is shown. The components shown inside the dotted line are located within the control circuit itself while the components shown outside the dotted line are located somewhere within the transmitter.

The components external of the control circuit find a box designated Z_1 which is the combined impedances of all the relays and other components used for energizing the transmitter. The battery furnishes the voltage and current necessary to energize the transmitter control relays and also provides the keying voltage which energizes the keying relay K_1 when the key (inserted into J_1) is depressed. To energize the transmitter we close the switch S_1 and apply power to the relay control circuit Z_1 . At the same time we apply power to the POWER-ON indicator I_1 , which will now be lit. R_1 is used to limit the current flowing through I_1 .

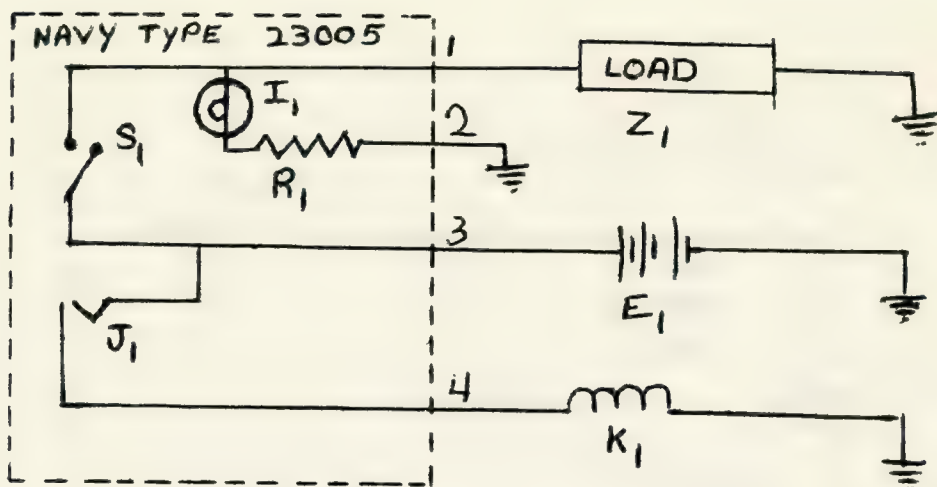


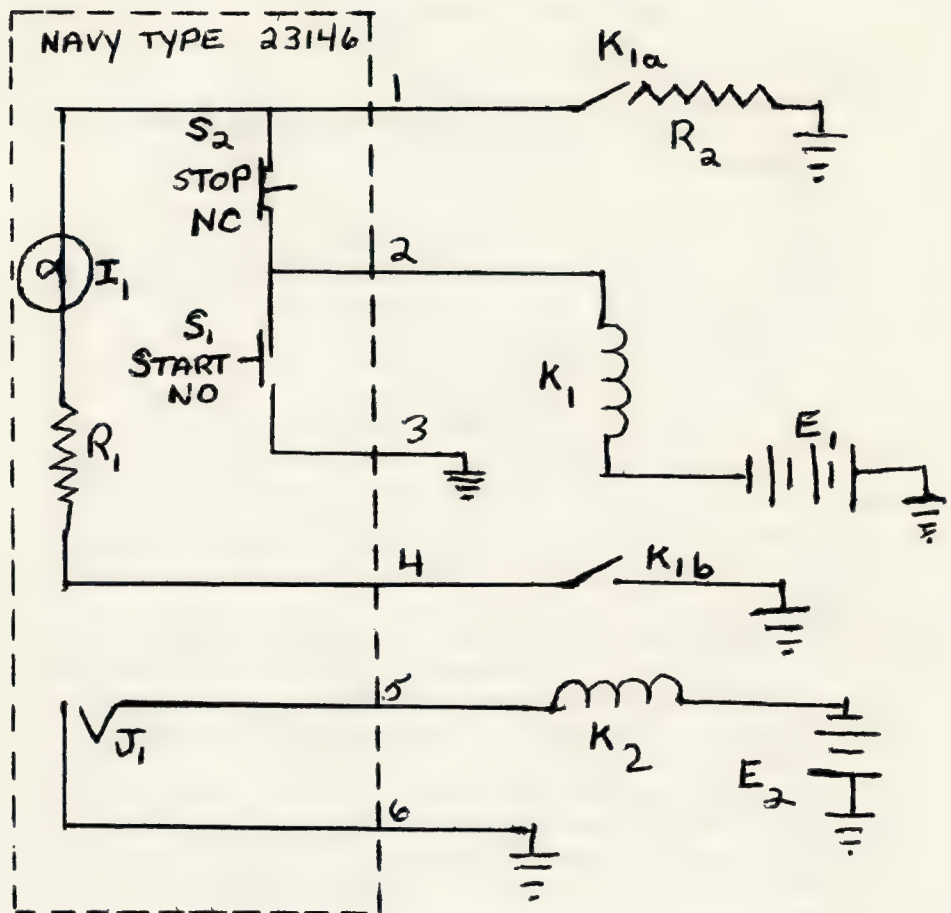
Figure 10

Figure 11 is the six wire control circuit. The components located within the control circuit are again shown inside the dotted line. The components outside the dotted line are located somewhere within the transmitter.

To energize the transmitter press the start switch S_1 which is a normally open switch. This causes a circuit to be completed and the circuit will draw current from the battery E_1 through the start switch and terminal 3 to ground. The current through relay K_1 causes this relay to energize and close contacts K_{1a} , K_{1b} and various other contacts (not shown) which supply power to the transmitter. Now that the contacts K_{1a} and K_{1b} (which are holding contacts) are closed, we can release the start switch and K_1 will remain energized. Current is also flowing through the POWER-ON indicator lamp I_1 so it will be lit.

K_2 is the keying relay (contacts not shown) which controls the keying circuits of the transmitter. When K_2 is energized by depressing a key inserted into J_1 , current flows from E_2 through relay K_2 and the key, then back to ground through terminal 6.

To de-energize the equipment press the normally closed stop switch S_2 and which interrupts the circuit and stops the current flow through K_1 , allowing all the contacts of K_1 to open.



AUDIO REMOTE AMPLIFIER

In almost every voice communication system there will be a remote audio amplifier.

The A.F. Amplifier AM-215B/U is a multiple input audio frequency amplifier designed for general communication work in conjunction with Naval electronic receiving equipment and associated loudspeaker units.

The amplifier is a five tube, three stage audio frequency amplifier with push-pull output, incorporating inverse feedback. The power supply and amplifier are included in one compact unit.

The three controls for the unit are mounted on the front panel along with a shutter type pilot light. The controls are respectively: a power on-off switch; a volume control knob operating a variable resistor; and a channel selector knob operating the channel selector switch. The channel selector switch has five positions and is used to select one of the five input channels as a source of audio power input for the amplifier.

Five 600 ohm input circuits are provided for connecting to sources of audio, such as radio receivers, of phono preamplifiers. One input circuit at a time is connected to the input transformer by the input selector as desired. The other input circuits are each terminated in a 620 ohm resistor. A maximum of two watts continuous audio power may be fed into each input. A minimum of approximately six milliwatts is required to produce full audio power output of ten watts.

The maximum output of the amplifier is ten watts with less than ten percent harmonic distortion at nominal voltage ratings. Two output impedances are provided, 600 ohms and 15 ohms, for feeding a conventional 600 ohm line or a 15 ohm speaker voice coil.

The power supply is built on the same chassis with the amplifier. It operates from a 110/115/120 volt AC power source, of 50 to 60 cycles, and supplies all filaments and plate power required by the amplifier.

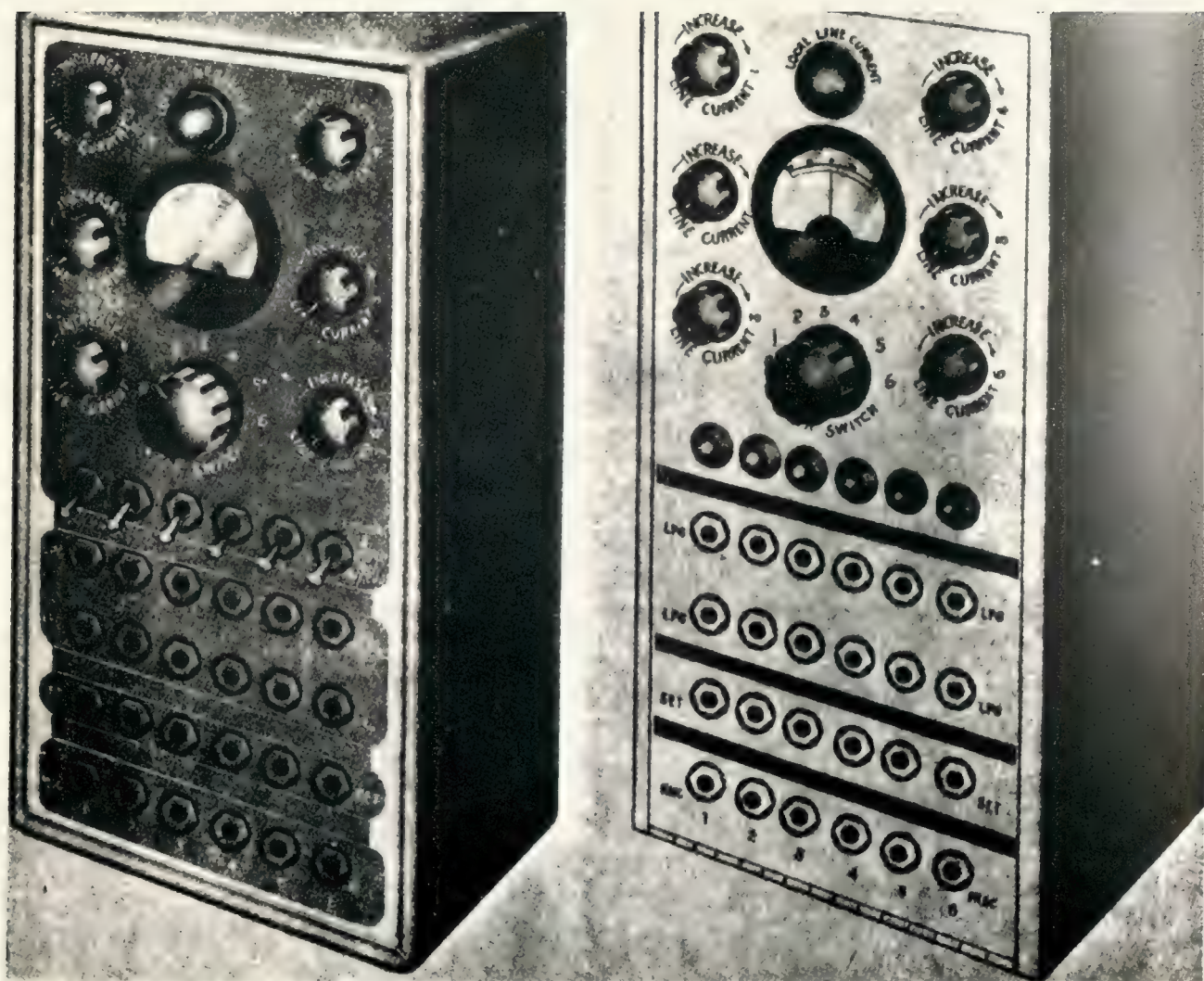


Figure 12. Teletype Panel TT-23/SG and
Teletypewriter Panel TT-23F/SG.

TELETYPE & COMMUNICATIONS PATCH PANELS.

Teletype Panels TT-23/SG, TT-23B/SG, and TT-23E/SG, Teletypewriter Panel TT-23F/SG, and Communication Patching Panels SB-1203/UG, SB-1210/UGQ are intended for shipboard use to facilitate interconnection and transfer of teletypewriters and various types of terminal equipments. Except for

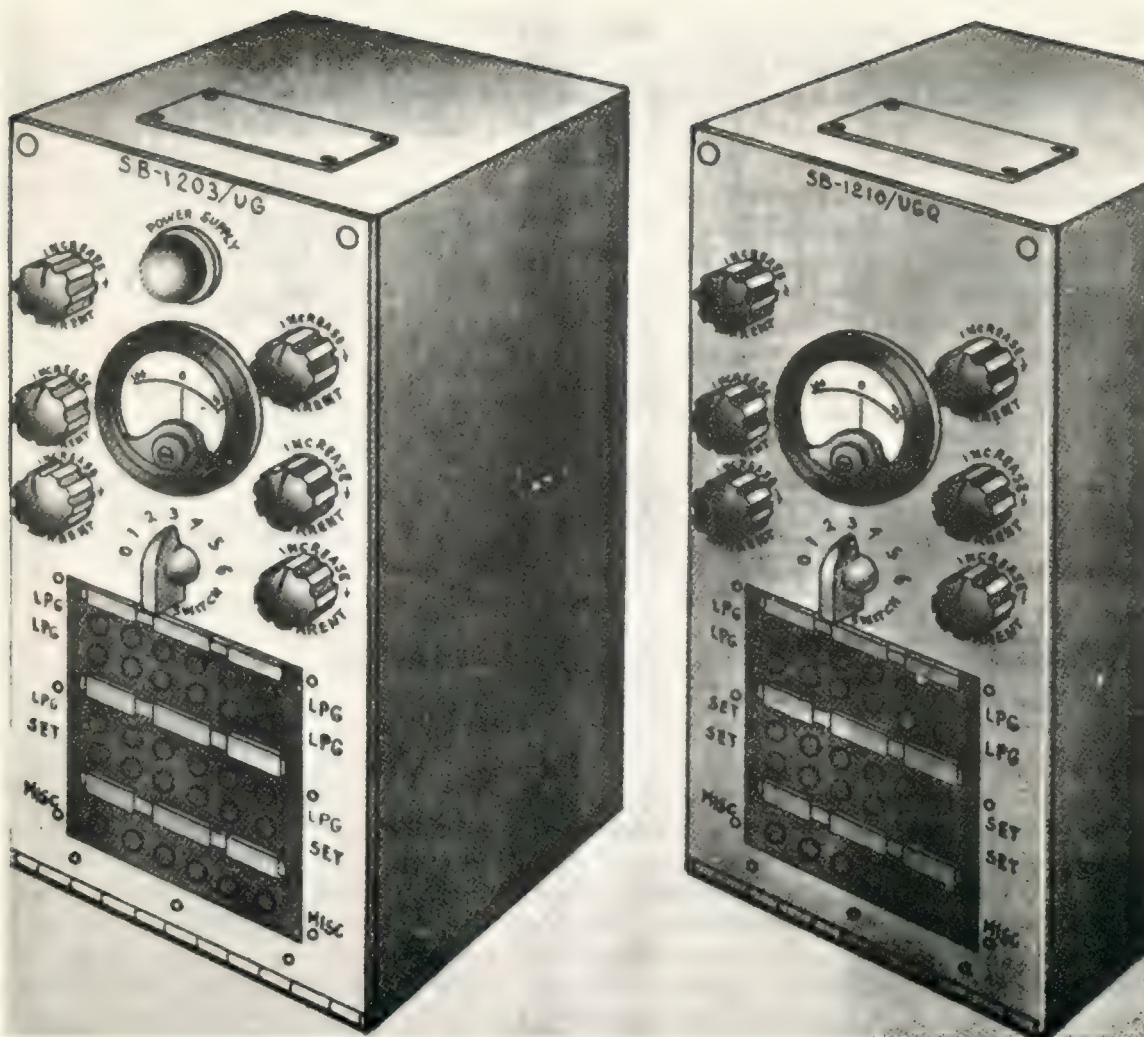


Figure 13. Communication Patching Panels
SB-1203/UG and SB-1210/UGQ.

differences in external appearance, minor differences in wiring, and some electrical components, the models are basically alike. For simplicity of explanation, the information will apply to all models unless otherwise stated.

Each panel provides six channels, each comprising a circuit of two looping jacks, at least one set jack, and a rheostat for adjusting line current. Line current is monitored by a milliammeter which can be switched to any one channel by a rotary selector

switch. There are six miscellaneous jacks to which may be connected any teletypewriter units not regularly assigned to a channel. Entry for cables terminating at a main terminal board inside the cabinet is made by making appropriate holes in the upper area on two sides of the cabinet. The number and size of the holes will vary with installation requirements.

Teletype Panels TT-23/SG, TT-23B/SG, and TT-23E/SG are essentially identical in construction details and repair parts, and have the following characteristics:

There are six channels each comprising a looping circuit of two looping jacks (LPG), one set jack (SET), a rheostat for adjusting line current, a toggle switch for selecting either a local (LOC CUR) or external source (EXT CUR) of line current (see figure 12).

There is a meter and a rotary selector switch for measuring line current in any channel. Calibrations on the meter scale are 0-100 ma.

There are six miscellaneous (MISC) jacks to which may be connected any teletypewriter equipment not regularly assigned to a channel.

There is a terminal block mounted inside of the cabinet to which all teletypewriter equipment, radio adapters, and local current connections are terminated.

Teletypewriter Panel TT-23F/SG is similar to the TT-23/SG except for changes in wiring and that the toggle switch has not been included. The line power supply function is accomplished by jumpers located in the interior of the box. Neon Keying indicators for each of the six channels are placed on the front of the panel. The scale of the meter is 100-0-100 ma instead of 0-100 ma as in the previous models.

Communication Patching Panels SB-1203/UG and SB-1210/UGQ are identical in essentials of operation or function. The SB-1210/UGQ is a modification of the SB-1203/UG and has been designed for patching requirements of secure teletypewriter channels. The panels are designed for mounting side-by-side when more than six channels are required. These panels are functionally interchangeable with all TT-23/UG series previously described, but parts are not interchangeable. The electrical circuit for each channel is similar to that of the TT-23F/SG except that there is no visual keying indicator in the channels.

DESCRIPTION OF CONTROLS

Six LINE CURRENT rheostats are located on the upper left and right sides of the front panel. Each control allows individual channel current to be adjusted. The current is usually set for 60 milliamperes.

The METER SWITCH is located directly below the CURRENT METER in the center of the front panel. Its purpose is to place the CURRENT METER into any of the six channels. The METER SWITCH is a two-pole rotary type, seven position control. Positions are marked from 0 to 6. The METER is not connected in any circuit in the 0 position.

The six toggle switches identified by panel markings LOC. CUR. EXT. CUR. (battery selector switch) are double pole-double-throw switches with locking action in both positions. When the radio adapter supplies its own current, the toggle switch should be set to EXT. CUR. position. If current is not supplied by the adapter, the switch is in the up or LOC. CUR. position.

The CURRENT METER is a d-c ammeter which indicates the line current in each channel. When the METER SWITCH is turned to any of the six channels, line current in the selected channel will be indicated on the CURRENT METER scale. Calibration of the scale is 0-100 ma on all models except models TT-23F/SG, SB-1203/UG, and SB-1210/UGQ which is 100-0-100 ma.

The lower portion of the front panel is composed of multiple rows of JACKS for patching operations. The JACKS identified as LPG and MISC are identical and are the standard type phone jacks. The jacks labeled SET incorporate a double-throw-double-pole switch. By inserting a DUMMY PLUG into the SET jack the teletypewriter originally in this channel is disconnected. If a teletypewriter is not wired into the same channel as the converter to be used, a patchcord is inserted into the proper teletypewriter SET jack and the other end in either one of the looping LPG jacks in the converter channel.

Sequence of operation is as follows: Turn all line current rheostats counter clockwise to allow passage of minimum current.

Turn on local line current supply at distribution panel (green indicator light on teletype panel on).

If the desired teletypewriter equipment is wired in the same looping channel as the radio adapter to be used, no patchcords are required.

If the radio adapter supplies own line current, flick toggle of battery selector switch down to "EXT CUR" position.

If not supplied, click switch up to "LOC CUR".position.

Turn meter selector switch to desired channel and adjust corresponding line current rheostat to 60 ma.

If the desired teletypewriter is not wired in the same looping channel as the radio adapter to be used, insert one end of a moulded patchcord (supplied with panel) in the proper teletypewriter jack and the other end in either one of the two looping jacks in the desired channel. The teletypewriter originally in this channel may be disconnected by inserting a dummy plug (supplied with panel) in the set jack, or it may be patched to the looping jacks of another channel in the same manner as described above.

WARNING

When patchcords are plugged in, 110 volts d.c. may appear between a nut and surrounding panel. To prevent inadvertent contact, synthetic rubber sleeves should be on plugs. If a patchcord is plugged in first into a loop jack, it will interrupt the circuit and may place 110 volts d.c. on the plug at the free end. Always plug into the SET jack before plugging into the looping LUG jack.

PRINCIPLE OF OPERATION

Each panel contains facilities for six identical channels. Figure 14 is a simplified schematic drawing for one typical channel or circuit. For simplicity of explanation and brevity, no attempt has been made to show simplified schematics for all models.

However, the diagram shown can apply to all models in as much as all models are functionally alike.

The following circuit is for one typical channel. The remaining five channels are exactly the same with the exception of component symbol numbers. A radio adapter is connected to terminals 1 and 2 of terminal board TB-101(LINE). When line current is not supplied by the loop, provisions are made to connect a local source of 115 volts d.c. across terminals 1 and 2 of TB-104. These connections are paralleled across the corresponding terminals of each loop and local current can be connected in or out of each loop by means of removable straps.

NOTE

On Models TT-23/SG, TT-23E/SG, and TT-23E/SG local current can be switched in or out of each channel by means of the selector toggle switch.

It should be noted that this local current is required for loops in which line current is not supplied. The power indicator lamp L-101 (not on model SB-1210/UGQ) indicates when this local current is available. The 1000-ohm resistor R-119 limits the current in any loop to a maximum of approximately 100 milliamperes.

The meter circuit consists of the milliammeter m-101, an 890-ohm

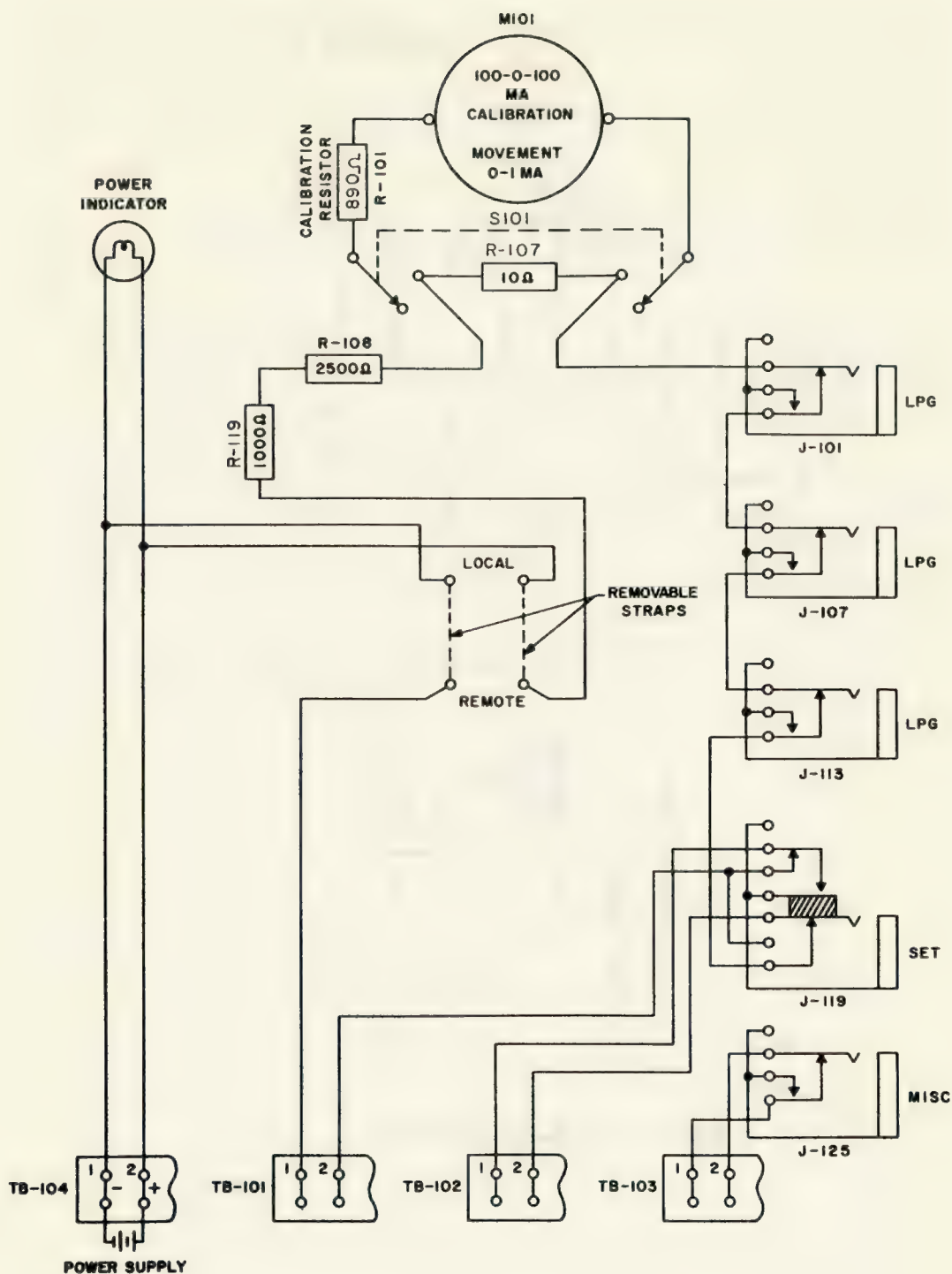


Figure 14. Communication Patching Panel SB-1203/UG, Single Channel Simplified Schematic Diagram

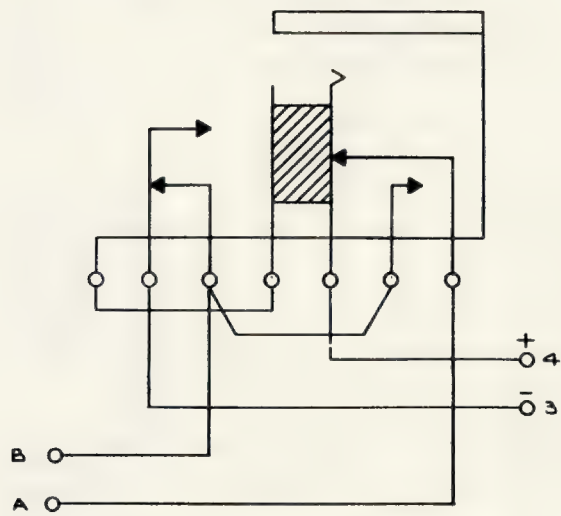
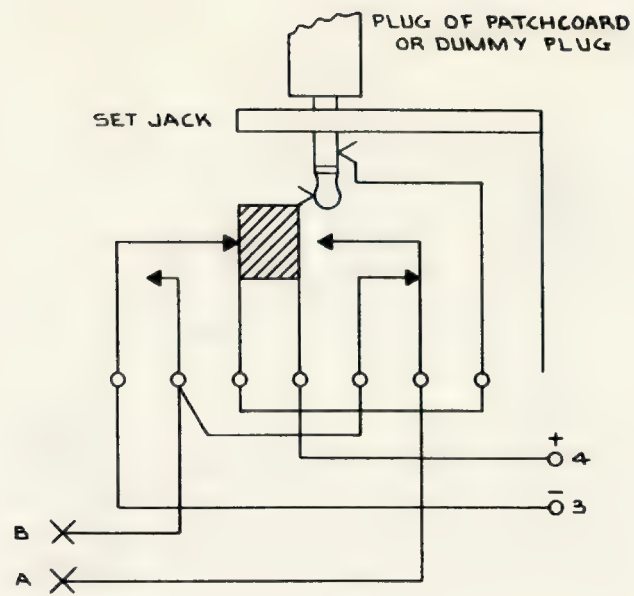


Figure 15. Set Jack Detail

resistor R-101, and a 10-ohm meter shunt resistor R-102. The meter selector switch S-101 is used to place the meter into any of the six channels or in the OFF position.

Line current in each channel is controlled by a 2500-ohm rheostat R-108. One terminal of the rheostat is connected to the first jack J-101 of a pair of looping jacks. The second looping jack J-107 is joined to a set jack J-113. The set jack is connected to the teletypewriter equipment at terminals 1 and 2 of TB-102. This completes the circuit between the radio adapter and the teletypewriter equipment.

By inserting a plug into the set jack J-119 the sleeve and tip of the plug are connected to terminals 1 and 2 of TB-102 respectively. Refer to figure 15. This action connects the plug to the **teletype** writer equipment wired at terminals 1 and 2. In addition, the remainder of the channel circuit is simultaneously disconnected from terminals 1 and 2 and closed.

Thus if it is desired to transfer a teletypewriter from one channel to any other channel, the teletypewriter is patched from its corresponding set jack to one of the two looping jacks in the channel to be used. If it is preferred that the teletypewriter equipment wired in this channel not operate, a dummy plug is inserted into the set jack J-119.

An additional teletypewriter may be connected to the miscellaneous jack and can be patched into any of the channels.

SYSTEMS EMPLOYING TRANSFER PANELS

A receiving-antenna distribution system, using antenna transfer panels, is shown in figure 16. The transfer panels are interconnected so that a receiver in any radio space may be connected to any receiving antenna, regardless of its topside location.

Two different views of the antenna transfer panel, type 23406, are shown in figure 17(A and B) a simplified schematic diagram is shown in figure 17C. These transfer panels provide the means by which as many as four radio receivers may be operated simultaneously from one antenna. At the transfer panel, each antenna is connected to a vertical row of four jacks. One jack is connected directly to the antenna; the other jacks are connected in parallel through 600-ohm decoupling resistors. The receivers connected to the three decoupled jacks operate at reduced efficiency.

There are nine interspace lines (one for each vertical row of four jacks) that connect to the various antennas (figure 17C). These lines connect to the vertical rows composed of four jacks (figure 17A). The escutcheon plate at the top of each line of four jacks is marked to indicate the remote termination of that line.

The 18 intraspace lines (lower 2 rows of jacks) connect to terminal boxes located at the various receiver, frequency meter, or other equipment positions. White escutcheon plates are mounted between each pair of jacks to enable the operator to mark the respective communications channel, frequencies, or schedules thereon. Patch cords are provided to complete the connections between the various jacks on the front of the panels.

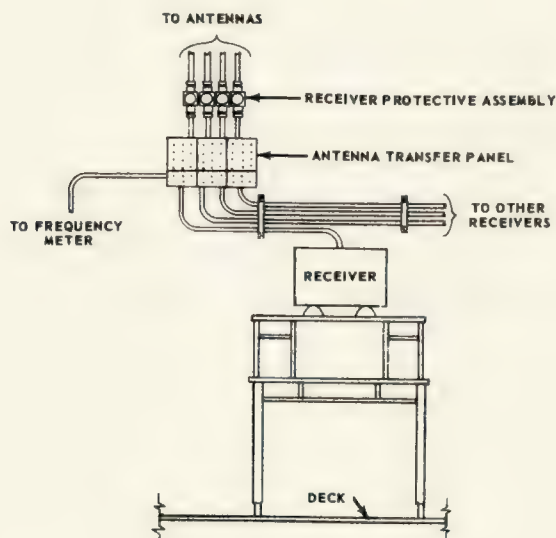


Figure 16.—Receiving-antenna distribution system, using antenna transfer panels.

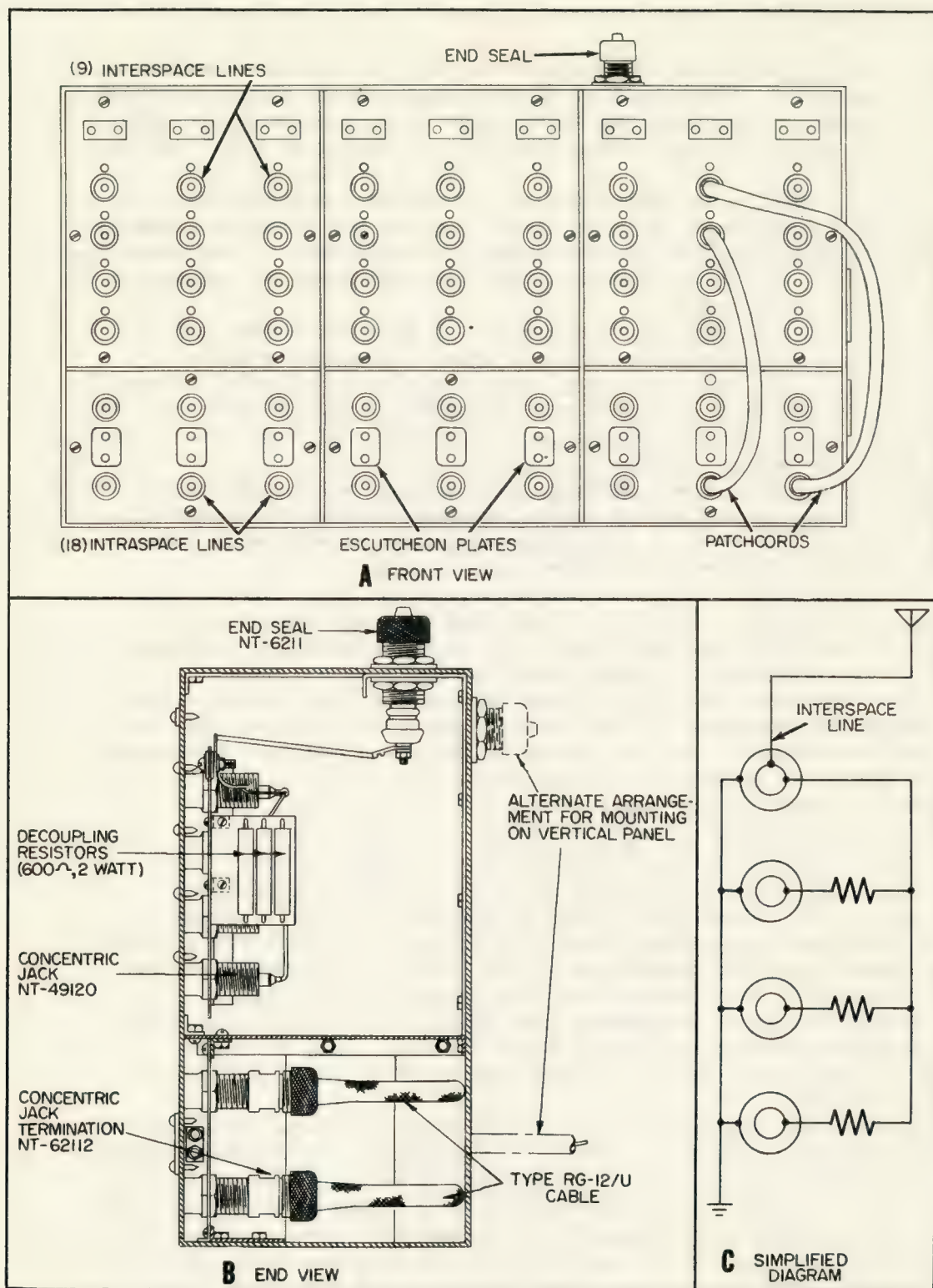


Figure 17. —Antenna transfer panel, type 23406.

SYSTEM EMPLOYING ANTENNA FILTER ASSEMBLY

A receiving-antenna distribution system, using a filter assembly, is shown in figure 18. This type of distribution system makes possible the multiple operation of a maximum of 28 radio receivers from a single antenna. It is generally preferable however, to limit the total number of receivers to 7.

This filter assembly or "multicoupler" provides 7 r-f channels in the frequency range from 14 kc to 32mc. Any or all of these channels may be used independently of, or simultaneously with, any of the other channels. Connections to the receivers are made by means of coaxial patch cords and a patch panel.

An external view of the filter assembly is shown in figure 18A. Separation of the frequency range into channels is accomplished by combinations of filter subassemblies, which plug into the main chassis. Each filter subassembly consists of complementary high-pass and low-pass filter sections, the common crossover frequency (F_c) of which marks the division between channels.

The filters not only guard against interference at frequencies falling outside the channel being used, but also prevent receivers connected to alternate rows of jacks from interacting with each other when their tuning and trimming adjustments are made.

A set of nine filter subassemblies is available, any six of which may be used at one time. The filter subassemblies are sealed units consisting of inductors and capacitors and are terminated in 4-terminal plugs, which are designed to engage octal receptacles on the main chassis. The subassemblies have numbers stamped on them that indicate their crossover frequencies. These numbers can be viewed through windows in the front panel. The six subassemblies that are used are assembled in the order of decreasing frequencies from left to right, as viewed from the front of the panel.

The filter panel (figure 18,B) contains 1 antenna input jack, 28 output jacks, 21 decoupling resistors, and 6 octal sockets. The antenna input jack and the 28 output jacks are all Navy type-49120 r-f connectors. (In the AN/SRA-12 Receiving Filter Assembly, these connectors have been changed to receptacle connectors which are improved quick-disconnect type r-f connectors.) The filter subassemblies plug into octal sockets in the rear of the main chassis (not shown).

To keep the losses to a minimum, the input and output of the filter assembly should be terminated in 180 ohms, however, only a slight reflection loss (of the order of 1.0 db) results when the input is terminated in 70 ohms.

Because Navy communications receivers generally operate throughout frequency bands that exceed the widths of the channels normally provided by the filter subassemblies, a given receiver must be connected to the particular row of output jacks that provides the signals of the desired frequency. For example, if a receiver is tuned from some frequency in the 7 to 14-mc band to some frequency in the 14 to 32-mc band, the patch cord would have to be moved from the output of the 14-to 7-mc subassembly unit to the output of the 32-to 14-mc subassembly unit.

When necessary, the bands of frequencies available in a given row of output jacks may be changed either by using different combinations of filter subassemblies or by removing various subassemblies and inserting "shorting plugs." provided with the equipment. These shorting plugs provide continuity between successive subassemblies, as required when testing or when a subassembly is removed for any reason, without the necessity for changing the position of the remaining subassemblies.

The red-painted jacks at the bottom of each row are directly connected to the subassemblies and should be used whenever maximum signal strength is desired. The other 3 jacks in each row are decoupled by 300-ohm resistors and are best suited for use with relatively strong signals (figure 18C). In the ideal arrangement, only one receiver is connected to each vertical row of jacks, and that receiver is connected to the bottom jack in each row. This means that seven receivers are fed from each antenna. At frequencies somewhat removed from the cross-over points, the performance of each of these seven receivers should be comparable with that obtained if a given one of the receivers were connected directly to an antenna. Likewise, the performance of 21 receivers connected to the "decoupled jacks" should be comparable with the performance of 3 receivers decoupled in like manner, using conventional patch panels with a given antenna.

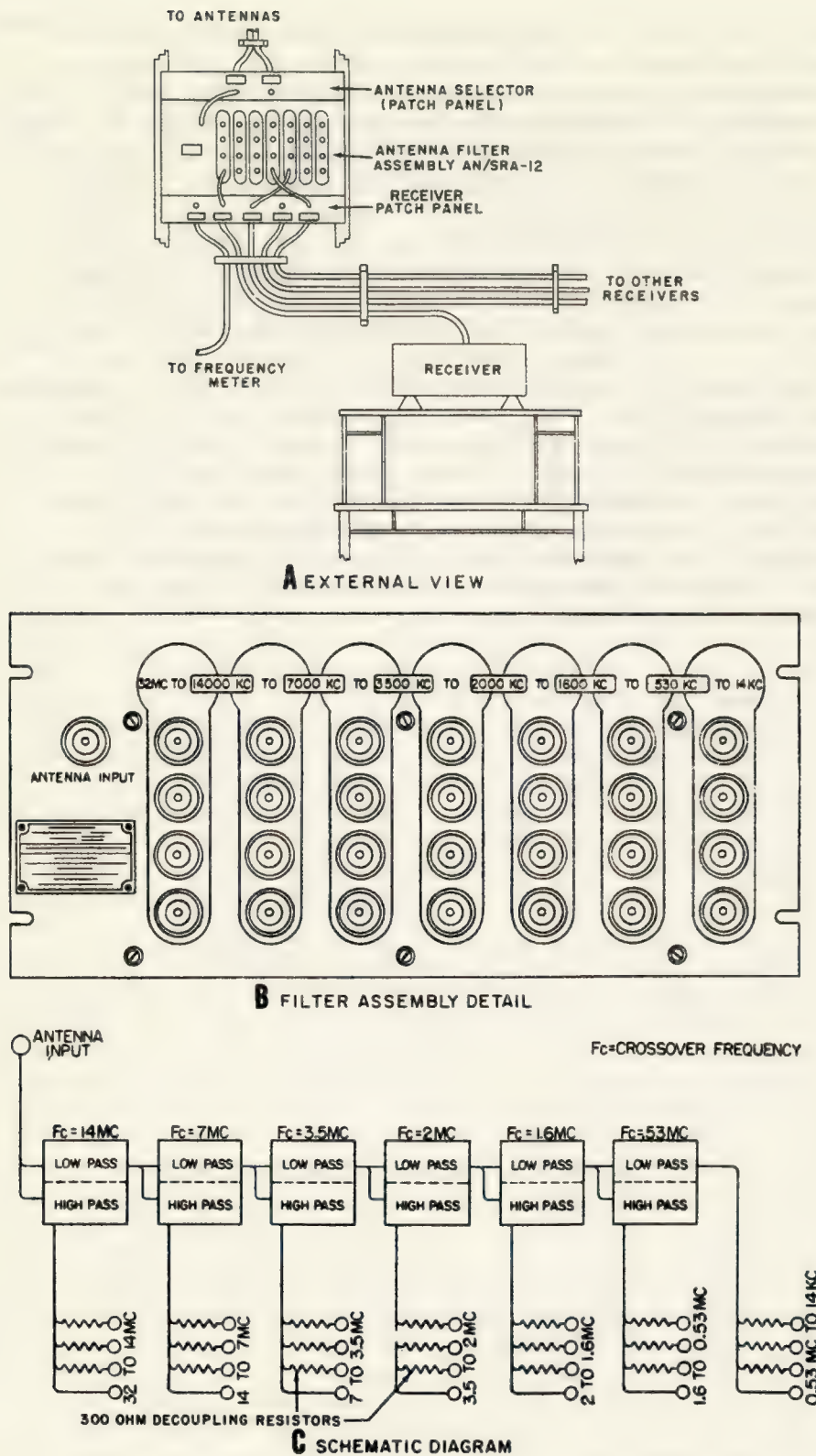


Figure 18. —Receiving-antenna distribution system, using antenna filter assembly.

VHF-UHF MULTICOUPLERS

Because of the increasing number of communications equipments required aboard naval vessels, it has become difficult to find suitable locations for the necessary additional antennas. One approach to the problem has been the use of multicouplers. These devices permit the simultaneous operation of a number of transmitters and/or receivers into a single antenna. Thus, the number of antennas can be reduced without sacrificing any of the required communications channels. This arrangement permits maximum use of the best available antenna locations and reduces the intercoupling between antennas.

One type of VHF-UHF multicoupler is shown in figure 19. (Identical to the CV-332A/UR. The CV-332A/UR has only manual tuning). When six units are used (as shown), a system is provided for operating six transmitters (and/or receivers) into a single antenna. One coupler is required for each transmitter or receiver, or transmitter-receiver combination. The frequency range of this particular equipment is 230 to 390 mc.

These couplers can be tuned manually to any frequency in this range. When used with automatic tuning transmitter equipment they may be tuned automatically to any one of 10 preset channels in this band by dialing the desired channel locally on the transmitter or on a remote channel selector.

CAUTION

When tuning this equipment manually, care must be taken not to approach closer than 15 MC to any other channel frequency.

This coupler consists of two major components: the coupling cavity, or r-f section, and the automatic-drive mechanism.

The r-f section is essentially an impedance-matching device. It is capable of transforming antenna loads ranging from 50 to 125 ohms into 50 ohms at the r-f feedline terminal. This results in maximum power transfer to or from the antenna system.

Correct adjustment of the tuning controls is indicated by the meter on the front panel of the unit. This meter indicates the output from the reflectometer, which is a device for indicating the magnitude of the power reflected back from the coupling circuit. When the controls are adjusted so that the tuning indicator reads zero, the system impedances are properly matched and there is minimum reflected power in the system.

This multicoupler is designed to be mounted vertically on a bulkhead or other solid support on small ships. Space limitations, however, may dictate other arrangements. In some cases, the couplers may be mounted horizontally overhead. This position, however, is inconvenient from the point of view of tuning.

A typical TED-AN/URR-13/35 installation employing multicouplers (CV-332A/UR) is illustrated in figure 20. One coupler unit is required for each transmitter or receiver, or transmitter-receiver combination.

HF MULTICOUPLERS

A system of h-f antenna couplers has been developed for simultaneously operating up to four transmitters into the same antenna in the frequency range of 2 to 26 mc. These antenna couplers are made up into four channel groups, each group operating in one of the following bands: 2-6 mc, 4-12 mc, 6-18 mc, and 9-26 mc. To obtain complete coverage from 2 to 26 mc, four coupler groups and four broad-band antennas are required.

The four types of h-f couplers are the AN/SRA-13, 14, 15, and 16. The AN/SRA-15 coupler (figure 21) which is typical of this group of couplers, provides for the simultaneous operation of four 500w transmitting equipments into a single broad-band antenna.

It covers the frequency range from 6 to 18 mc and will operate into any antenna having a standing wave ratio (relative to 50 ohms) of 3 to 1 or better. The four transmitters connected to this coupler may be operated anywhere in the frequency range from 6 to 18 mc provided there is sufficient separation between the operating frequencies.

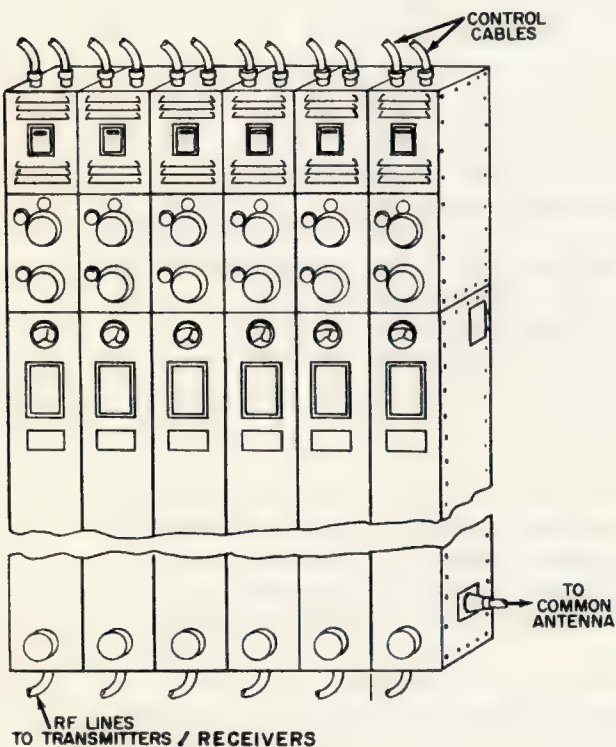


Figure 19. VHF-UHF multicoupler (CU-255/UR).

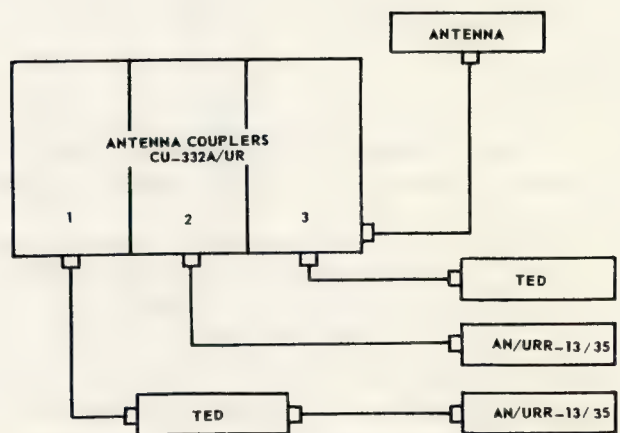


Figure 20. TED and AN/URR-13/35 installation employing a multicoupler.

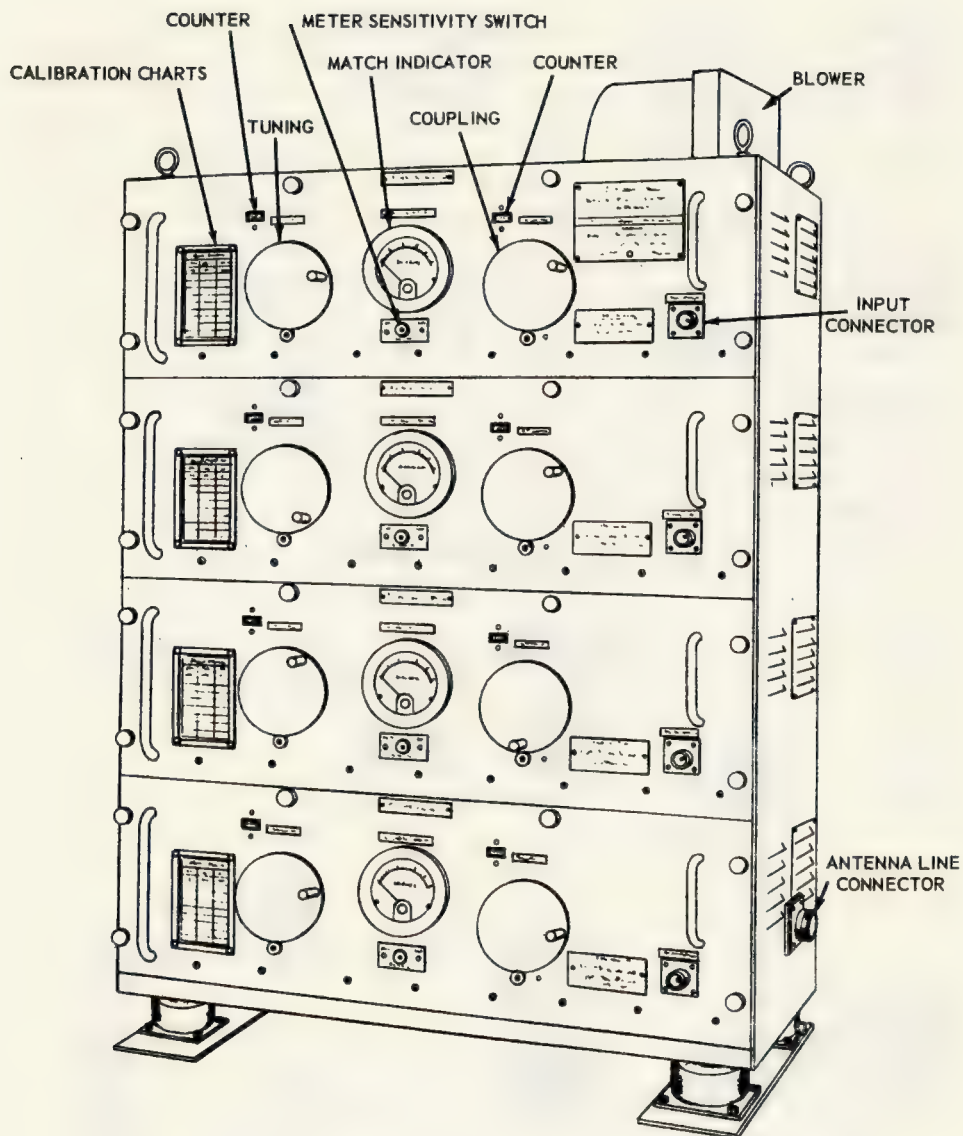


Figure 21. —Antenna multicoupler AN/SRA-15.

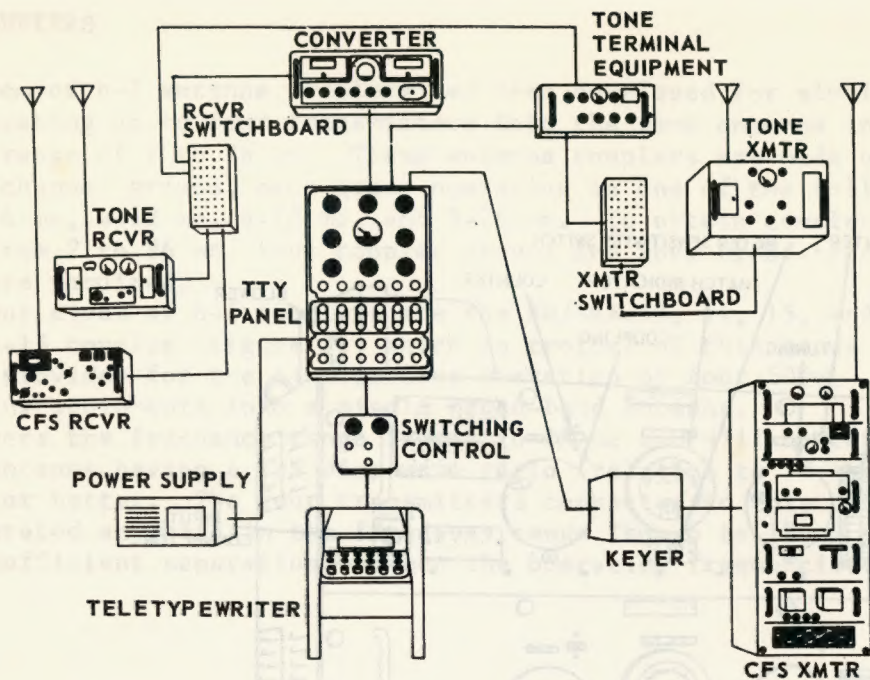


Figure 22. -- Basic radio teletype system.

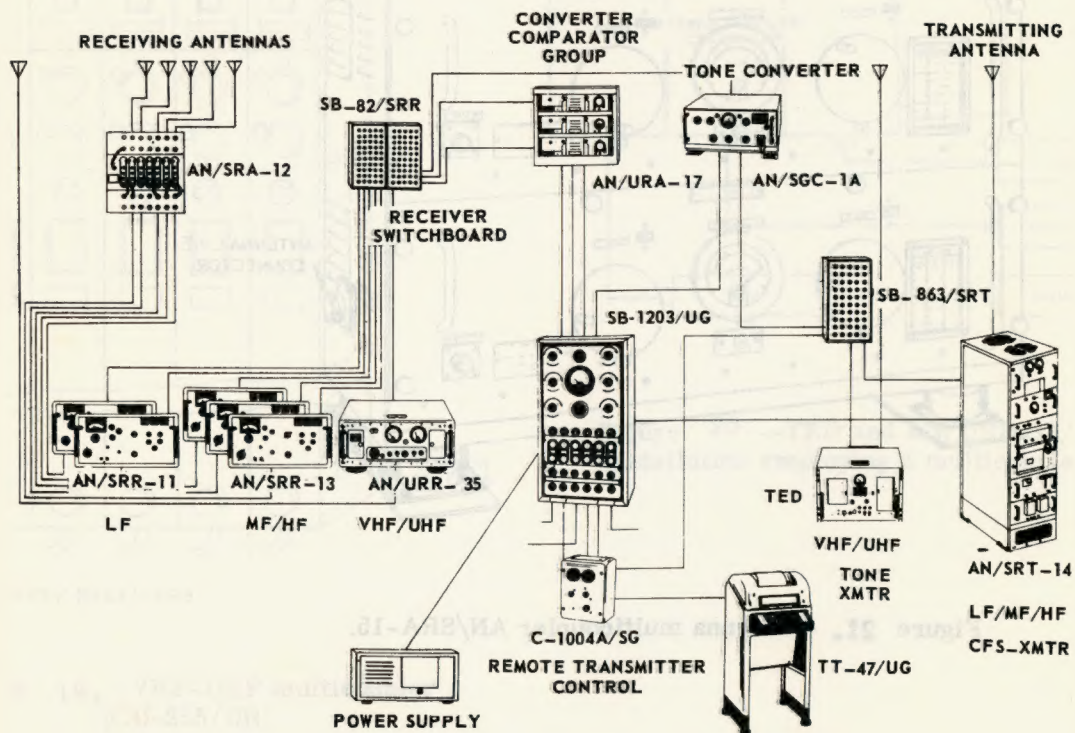


Figure 23. -- Teletype system employing diversity reception

When the carrier frequency-shift system(long range) is combined with the tone-modulated system(short range), several more pieces of equipment are needed--a TELETYPE PANEL, a POWER SUPPLY, a SWITCHING CONTROL, a TRANSMITTER SWITCHBOARD, and a RECEIVER SWITCHBOARD, as illustrated in figure 22.

The teletype panel is capable of handling six channels, or "loops." The power supply furnishes the direct "looping" current for all teletype direct-current signals. Located at the teleprinter is the switching control, which is used to select the desired system. The transmitter and receiver switchboards are used to join the radio teletype systems with other communication systems on board ship.

The tone-modulated system and the carrier-frequency-shift system are combined to form one teletype system in shipboard communications.

The frequency-shift system, used in the LF to HF bands, is the best way to send the rapidly keyed signals of the teletypewriter over long distances. Fading and interference are sometimes major problems in these bands.

Because a single r-f carrier usually does not fade simultaneously in areas separated by more than one wavelength, and because fading of carriers of different frequencies usually does not occur simultaneously at the same point, the Navy has taken advantage of this situation by the use of two methods of DIVERSITY RECEPTION.

SPACE DIVERSITY and FREQUENCY DIVERSITY

A basic teletype system employing diversity reception is illustrated in figure 23.

CRYPTO

With the world situation as it is, the need for rapid communications is increasing daily in our United States Navy.

This is one reason for Telecommunications, and with the increased communications, there is a growing need for secrecy. In more and more cases the Navy is sending messages in a manner that makes it difficult if not impossible for the enemies of this country to understand what was sent and when it was sent.

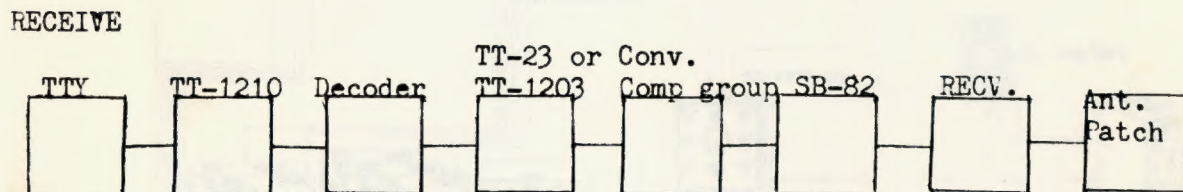
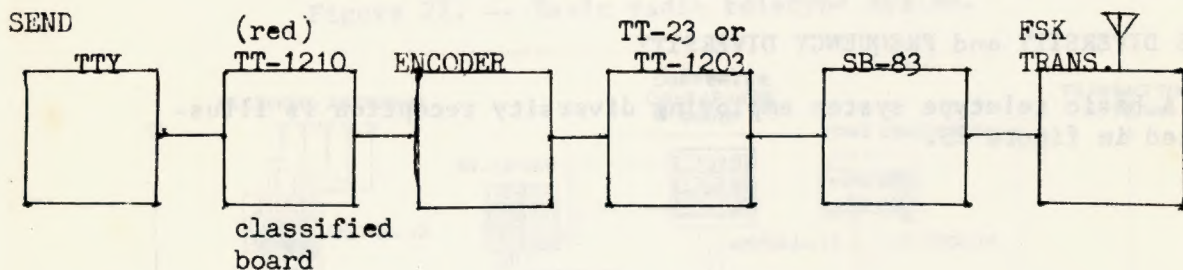
In order to do this they are enciphering or encoding all messages in one way or another. There are two basic systems of encoding used in the Navy today

The first system is the On-line system. In the On-line system the messages are enciphered as the message is transmitted and deciphered as the message is received.

The enciphering and deciphering may be done electrically or mechanically.

The On-line system gains speed in the transmission and reception of enciphered messages. The On-line system gain traffic flow and security, because the send side is continuously sending out random pulses, with or without a teletype input.

The below block diagram illustrates how the On-line encoding device fits into today's present teletype system.



The second system is the Off-line system. As the name implies, the message must be enciphered before it is sent and deciphered after it is received.

With this system it takes longer to transmit and receive the messages. The reason for keeping the Off-line system is so we have a back up for the On-line system if it breaks down. The Off-line system can be sent over an unclassified teletype circuit or even over a CW circuit, and received in the same manner.

